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ABSTRACT

This study examined curricular reform processes at two Swedish institutes of technology through a gender perspective, relating them to two social theories the reproduction theory of Bourdieu and Passeron and the gender contract theory of Yvonne Hirdman. The aim of the reform process was to make educational programs in computer engineering more attractive to female students. Data were gathered by interviewing academic staff involved in the reform process at Linkoping Institute of Technology and Chalmers University of Technology and through observations of planning meetings. The results point out several obstacles to gender-related reforms, including stereotypical conceptions of women and lack of knowledge on gender issues among the reformers, the particular position and responsibilities given to female reformers, the importance of maintaining the status of a single program, the heritage of engineering education as a whole, and the need for other reforms (e.g., pedagogical reforms) which are perceived of as relatively easy to accomplish, whereas gender reform is both more profound and more difficult. It was also found that even if the reformed programs managed to increase recruitment of female students, their curricula were not perceived by faculty to be especially female-friendly. Seven appendixes provide information on the study methodology. (Contains 165 references.) (MDM)

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Bringing Women into Computer Engineering

Curriculum Reform Processes at Two Institutes of Technology

Minna Salminen-Karlsson

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Innehållsförteckning

1. Introduction.. 9
  What this study is and is not 9
  What this study looks at and how..10
  Some concepts that are used...12
  Introduction to the rest of the book..13

2. Engineering education in a gender perspective.........................15
  What is a Swedish "civilingenjör" 15
  Women in engineering education..17
    A historical background 17
    Scandinavian research on women and engineering education 20
    Universities of technology as environments for female students 21
    Engineering education as an ordeal..............................23
    Changing engineering education to recruit more women 26

3. Gender och gender contracts 28
  A choice of perspectives 28
  Gender...31
  Gender contracts 37
    What is a Gender Contract 37
    Change in gender contracts 39

4. Examples of gender contracts on three different levels 43
  Institutional level - gender in organisations..........................43
    Women and men in organisations 43
    Tokenism 46
    Does balance in numbers change contracts? 49
    Gender in Higher Education..50
  Individual level - identity..52
  The cultural overlay level - gender and technology 57
    Technology is Masculine in itself.................................57
    How about the computer?..59
    Looking at Computer Engineering Education in Terms of Gender Contracts.................................63

5. Reproduction and reform in higher education 66
The work of Pierre Bourdieu 66
Bourdieu and gender 67
Habitus, capital, field and doxa 70
On reproduction 74
Looking at engineering education with Bourdieuan eyes 76
Vertical and Horizontal Reproduction 80
Lundgren's model of two kinds of reproduction in education 80
Central authorities and local arenas 83

6. Method 85
Description of the method 85
Observations 87
Interviews 90
Other data sources 92
Methodological reflections 93
On interviewing engineering faculty 93
My way to grounded theory and back again 95
Criteria of qualitative research and my study 97
Dilemmas in reporting 99

7. How gender equality in higher education became pedagogical reforms in engineeing education 101
Interactions on the central level 101
Transporting the money to the local level 106
Project evaluation 110

8.Introduction to the empirical report 113
Themes of the empirical chapters 113
A short chronological account 115
LiTH 116
Chalmers 118

9. Reformers' ideas about women and engineering 121
Why should there be more women in computer engineering 121
Why do women stay out of engineering education 123
Women's situation in the present education 126
Female computer engineering students as special 128

Women as learners and problem-based learning 129
Chalmers 132
Summary of Chapter Nine 134

10. Work in the planning groups 137
Competing interests 137
Lack of knowledge 143
The position of women in the planning work 151
Even at Chalmers many of the Pedagogical interest, knowledge and women's position in the Chalmers team 155
Summary of chapter ten 160

11. The institutional context 163
Making engineering education - keeping it technical and tough 164
Relating to different groups in the context 167
What did the money do? 170
The institutional leadership 171
Ambivalence towards a feminine image 174
The Chalmers context 177
Summary of chapter eleven 183

12. Some features of the programmes as planned 185
Female-friendliness at LiTH 185
A programme for ordinary women? 188
Female-friendliness at Chalmers 191
Summary of chapter 12 193

13. The programmes as they turned out 195
Basic data 196
Is the programme gender-inclusive? 196
The programme in its context 200
Conceptions of female students 201
Sex vs. academic orientation 203
General impressions from the first year at Chalmers 205
    Implicit expectations on programming at Chalmers 208
    Problems with academic orientation at Chalmers 210
Summary of chapter thirteen 212

14. Discussion of the results 215
- Is gender inclusive equivalent to recruiting many women? 216
- The results in summary 219
- The worlds of Hirdman and Bourdieu 222
- The interplay between state authorities, the Council and the universities 223
- University of technology as a context for gender reform 226
- Looking at the programmes as reproduction of masculine dominance 234
- What happened to the gender contracts 236
- Possibilities for change 239
- References 242

1. Introduction

What this study is and is not

This study is about curriculum reform and gender in engineering education. It seeks to understand how the present gender conceptions and gender relations in engineering education influence a curricular reform with the expressed aim of increasing the percentage of female students.

This study tells one story about two reform teams at two universities. It is one of the possible stories that could be told of these reforms.[1] What is special about my story is that it is focused on gender. I pursue a somewhat lengthy discussion about the concept of gender in chapter 2, and it comes to a conclusion that gender is both an abstract symbolic category which is used in our perception of the world and something that is created and recreated in human interaction. Both these aspects are interwoven in my story and give it its focus and its flavour.

But even when focusing on gender, several different stories could be told about the same process. The reformers' own stories might well differ from mine. And the story which emerged from the research process is different from the one which I started to write. In the final conclusions there is an underlying conflict perspective, an assumption that intentions to change the gender power balance in engineering education are bound to meet resistance and lead to conflicts, and results which are particularly illuminated in this perspective are elaborated on. From being more tentative, the assumption that gender reforms in engineering curriculum are connected to gender power relations has gained strength during the research process.

And even when focusing on gender from a conflict perspective, the reform processes could have resulted in other kinds of stories. An obvious research question would have been to study gender power aspects in the changes these reforms brought about for the students. I have looked at the results of the reforms only to a slight extent, and not at all from the student perspective. Concentrating on the academic staff is complicated enough. Because there is a body of research on the situation of students - especially female students - in engineering education, while gender aspects among the academic staff in engineering have been considered to a much lesser degree (and not at all in Sweden, except for some studies about female graduate students), focusing on this group seemed to be more important.

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[1] Some others are already published: The official evaluation reports (Wistedt, 1996 and 1998), and reports from the Chalmers reformers themselves (Jansson, 1995 and 1998). In addition, there has been a number of newspaper and magazine articles about the new programmes.

What this study looks at and how

In 1993 a state body called the Council for the Renewal of Higher Education announced sizeable grants to be allocated to higher education institutions which could present project plans for major reforms in their technical and scientific programmes. The reforms should be comprehensive and have the aim of making the education more attractive to female students.

Five universities were chosen to receive a grant, given for three years and aimed at financing the planning of the reform, while the ordinary running of the programme would be financed by the institution. Two of the universities had an ambition to reform the extremely male-dominated programme of computer engineering, Linköping Institute of Technology (LiTH) by starting a totally new programme, and Chalmers University of Technology, by making changes in the present one.

On both sites those who came to do the reform work were mainly members of the academic staff - even if administrators, students and representatives from industry were also engaged. This study is mainly about the group in Linköping, their meetings, concerns and ideas on gender and reform, and the reformers at Chalmers came to be a supplement and a contrast to the Linköping team. Around the reform teams are both the universities, and, farther out, state authorities which have made the wheel turn. There is a myriad of aspects which can be scrutinised. The study has as its point of departure a few questions, which can be posed to the empirical data:

1) How are female students perceived among the reformers?
2) How do the prevailing gender relations affect the functioning of the reform groups?
3) How do the reformers relate to gender issues in engineering education in general?
4) What are the possibilities and restrictions in the institutional context for changing gender relations in engineering education?

The answers to these questions lend themselves to interpretation both in the framework of gender contracts, as formulated by Hirdman (1988, 1990, 1992) and in the view on education as reproduction, based both on Bourdieu & Passeron (1977) and Lundgren (1983). To create an understanding of the reproduction of gender contracts in the area of engineering education a combination of the two kinds of theories is made in this study. In addition, the theories themselves are examined and illuminated, when they are compared and combined.

This choice of basic perspectives can, naturally, be discussed. One important objection can be that none of these theoretical frames is commonly known as dealing with change. They are primarily created to analyse a certain state of affairs, instead of change processes, while the starting point of this study is educational reform. However, Hirdman, Bourdieu and Lundgren all actually allow for constant change in their theories – in the contract negotiations between genders as in Hirdman, in changing games about the positioning of individuals and institutions as in Bourdieu, and in the shifting balance between the two reproductive spheres, as in Lundgren. Thus the theoretical frames gave some guidance to looking at change in reproduction – which was what could be expected to be seen when looking at two gender reform groups in an extremely gender-unbalanced educational environment.

It can also be argued that Hirdman does not particularly refer to processes on the level of big institutions, such as universities, and that Bourdieu and Lundgren do not talk about gender. However, all give quite wide theoretical frames. Hirdman describes different societal levels on which gender contracts exist, and curriculum reforms in engineering education have connections to all of them. And the circumstance that gender is not mentioned by Bourdieu or Lundgren hardly changes the basics of the theory that central tasks for the educational system are reproducing the work force, power relations, and its own autonomous position with its own traditions – where gender relations find space under the domain of power relations. (A more detailed argumentation on Bourdieu can be found in chapter 5.)

Combining two theories from two different areas of research can be expected to enrich both of them. Gender contract theories may benefit from a study where the reproduction of gender relations in the area of technology is seen in the light of educational sociology. And reproduction theory in educational sociology may benefit from the insight that power relations exist and are reproduced by educational institutions, not only between social classes, but also between men and women.

Some concepts that are used

The concepts of gender, gender contract and reproduction are discussed in chapters 2 and 3. But some other concepts which are used frequently may need an explanation:

Engineering education in this study refers to the Swedish education of master's level engineers (civilingenjör). There are other, shorter, programmes for engineering education as well, and everything that is said about engineering education in this study cannot be applied to them.

Consequently, *engineer* refers only to master's level engineers and *engineering education institution* to universities that educate master's level engineers. Engineering education institution is used synonymously with*university of technology.*

The concept of *institution* is used in two relevant knowledge areas: gender studies and educational sociology. In educational sociology, especially that pertaining to higher education, an institution is synonymous with a university or a polytechnic (or, in the USA, a college). In the area of gender studies, particularly in the gender contract theory of Hirdman (1988), which is used in my analysis, the "institutional level" is used in its wide sociological sense. However, for the purposes of this study her usage of "institution" can be seen as referring to higher education institutions - even if the denotation in the original theory is much larger.

The terms*"university of technology"* and*"engineering education"* are used here in a somewhat narrower sense than their normal definition. There are some niches at universities of technology, some study programmes, where at least the numerical gender relations are different from those I refer to. My focus is on computer engineering and, as far as can be concluded from literature, much of the gender and power relations are fairly similar in most of engineering education. In the following, I disregard the fact that there is also a great deal of variation as to the percentage of females in different study programmes in engineering. Apart from chemistry, where there has always been a high percentage of women, in particular the new, more application-oriented and interdisciplinary programmes have attracted female students. This far, most of these programmes are small compared with the traditional male-dominated ones.

What is normally imparted in these universities of technology I call *masculine education*. As a contrast to that the concept *of gender-inclusive education* is used. The masculinity of the education shows in several ways, both as to curriculum content, the organisation of studies and the general ethos and values (Seymour & Hewitt, 1997; Kvande, 1984, Hacker, 1989). In general it can be said that engineering education has been and still is created and conducted mainly by men, and that it shows several features which are accepted and even cherished by male students, but which trouble and disadvantage women. This is further elaborated in Chapter 2. Gender-inclusive education is one where women's preferences, as much as is known about them, are taken into account. Typically this has included broadening the curriculum content outside narrowly technical areas, changing teaching methods towards more collaboration and dialogue, and paying attention to the social situation of the female students in the male-dominated environment. Gender-inclusive education is the term appearing to an increasing extent internationally, but the groups which are studied here themselves use the concepts that can be translated to *female-friendly education*. That is why the concept of female-friendly education is used as a synonym to gender-inclusive education when describing and analysing the reform processes themselves.

Introduction to the rest of the book

The book starts with a brief review of engineering education in Sweden in Chapter 2, and especially the situation of female engineering students, to make the reader acquainted with the cultural context in which this study was made.

After presenting the context, the glasses through which it is seen in this study have to be presented. Thus, chapter 3 introduces the concepts of gender and gender contracts, and chapter 4 gives three lengthy examples of gender contracts on different levels from relevant areas: 1) gendered interaction patterns and power relations in organisations as an example from the institutional level; 2) the gender identity of academic and engineering women as an example from the individual level and 3) the prevailing conceptions of technology as masculine as an example from the cultural overlay level.

Chapter 5 introduces the educational sphere and the concepts of reproduction and reform. It begins with the idea of education as reproduction as it is presented by Bourdieu & Passeron (1977), and elaborates one aspect of it specifically: the autonomy of the educational system and what it means for centrally initiated reforms.

My acquaintance with the reform groups is described in Chapter 6, about the research method. Besides the descriptions of how I collected information about them and of some problematics related to interviewing, this chapter also recounts my wanderings to and from the grounded theory method in the data analysis phase.

Chapters 7 to 13 form the empirical part of the study. Chapter 7 functions as a prologue, recounting the history behind the state grants which initiated the reform work.

After an introduction in Chapter 8, Chapters 9 to 11 focus on the reformers and their work. In Chapter 9 the ideas of individual reformers about female students are examined. Chapter 10 looks at which interaction patterns, interests and shortcomings affected the day-to-day work of the teams. Chapter 11 takes a view of the context from the teams' perspective - what both implicit and explicit restrictions were made to their work and what role the institutional leadership played in the process. These three chapters should actually be read in parallel and form the core of the study.

Chapters 12 and 13 give an account of what finally became of the efforts of the reform teams. They are not written from the perspective of the students, but mirror the teachers' views on the programmes, on their female students and the institutional reception of the reforms.

In Chapter 14 the analyses, grounded on the empirical data, are discussed in the light of the concepts presented in the beginning of the book and related to other research on engineering education.

2. Engineering education in a gender perspective

This chapter aims to give a reasonably thorough description of the history of, mainly, Swedish engineering education, and its present practices and ideals, to make the cultural context of the two reform projects understandable. As the gender aspects of those projects are the object of study, even this chapter looks at engineering education with gendered eyes, giving examples of the masculinity of the education and the position of women therein.

A short historical background begins the chapter, as much of what are the traditions of engineering education today seems to have already been grounded a hundred years ago, when engineers became an important professional group in the society. Most of the chapter presents and discusses recent research on women in engineering education, to give an impression of how the educational environment looks from women's viewpoint and how it affects them. Finally, some accounts of, and reflections on, change in engineering education to promote women are presented.

What is a Swedish "civilingenjör"

The Swedish title for a master's level engineer, "civilingenjör" has carried and still carries status. To date being a "civilingenjör" has meant having gone through a tough educational programme, been drilled in Mathematics, having a solid all-round technical knowledge, and specialist knowledge in one of the fields of engineering. In contrast, economics, social science and humanities have a very marginal position in the education. Fifty percent of the leaders of major industrial companies both in 1930 and in 1980 were master's level engineers (Berner, 1992).

Engineering education is still regarded as educating an élite – even if much of it is also mass education of a white collar work force in technical industry. The programmes send out an image of being tough, requiring both intelligence and commitment, but leading to good jobs. They are not described as being "fun" or promoting personal growth, but as being an ordeal you need to endure to get the knowledge which will set you on the road towards a rewarding career. Among engineering educators élitist thinking can be de–tected, for example, by reading student and faculty magazines, and the professional magazine of the engineering association. Even if the vast number of engineers educated today in itself indicates that it is not a small and exclusive group of men in high positions any more, it is the prevailing élitist thinking in the educational institutions which is relevant in this study.

Master of engineering programmes drill the students in mathematics and give them a solid all-round technical knowledge, in addition to the specialist knowledge in their special field. Getting a Master in engineering is supposed to take 4.5 years, but often takes longer due to the fact that practically nobody goes through without failing examinations on their first try. The curriculum is crowded. The studies are supposed to require more than 40 hours per week, and students witness the difficulty of keeping up a social life outside school.

Swedish engineering education has a distinct initiation rite, the *nollning,* which, even if it is only of a couple of weeks' duration, is an important part of the image of engineering education. The new students are taken care of by the older ones and are submitted to different experiences and made to perform certain tasks – not seldom humiliating, or involving the breaking of normal codes of behaviour. Excessive beer drinking is also seen as one of the features. Even if nollning is the main concern of both the new students and the older students involved during the weeks it is carried on, and even if there is criticism of its methods, it is supported by the educational institutions as a tradition which helps the new students to get to know each other and the university, and creates solidarity among the group.[2]

There are only five universities of technology in Sweden, entitled to give a Master's level degree in engineering.[3] The institutions being only five, they can be arranged in a status hierarchy, and are constantly competing. The different programmes are also often referred to in terms of status. Thus, for example, computer engineering has a higher status than industrial engineering and management, while the theoretical programme of engineering physics ranks even a bit higher. Computer engineering programmes more or less rank each other according to the amount of cultural capital such as the technological content of the education, the perceived "difficulty" of the programme, the attractiveness to students (measured by the lowest average grades from secondary education of those who are admitted) and the sophistication of technological research at the institution. This kind of aspects are thus extremely important.

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[2] Lately, more caring social aspects are said to have been integrated in nollning in that the older students involved are also taught about their responsibility as guides for the newcomers and the voluntary nature of the activities is emphasized. The content of nollning also varies - but the image still is the same, as is much of the content, and staying outside nollning also means staying outside the affinity in creation.

[3] At the time of my study Uppsala University also had this kind of educational programmes, but was not regarded as a university of technology.

Women in engineering education

A historical background

Swedish engineering education in the beginning of the 20th century from a gender perspective is vividly described by Boel Berner in her study "*Glada och förfärliga män med räknestickor...* " (Glad and terrible men with their slide rules) (1996). She studies the Royal Institute of Technology (KTH), one of the two engineering institutions in Sweden at the turn of the century, and comes to the conclusion that this institution provided a homosocial milieu for, mainly, young men from the bourgeoisie where they were both drilled and given the necessary cultural and social capital to distinguish themselves as the central figures of the industrialised society.

Berner shows how one of the main functions of the education was to distinguish these students from the graduates of lower level technical studies, or from men with a long and solid working experience. To this end the education was built more and more built on mathematics and science and made very theoretical. Towards the end of the education another kind of experiences were provided – during study tours to industrial plants the engineers-to-be were taught their proper place in the hierarchies of small industrial communities and the behavioural patterns that were suitable for this.

Berner sees the pattern as "sponsored mobility". The entrance requirements to the institution selected a group of men who had a secondary education background that only some 2% of the male population in the country acquired, and who had attained their right to study at the institution in hard competition. But once they were in, the students in general, even when given a hard time with their studies, were seen as the future leaders of the country and "sponsored" to that end both by their teachers and by each other. Once they had shown that they were worthy and compliant members of the student body, they could be assured of the cultural and social capital which would be needed to rise to the level of the technological élite. Women[4], regarded as "the other" could not prove themselves to be either worthy or compliant, regardless of their actual abilities and behaviour.

But the "sponsoring" did not mean an easy path. The work load was heavy - so heavy that overstrain was an officially debated problem. Time discipline was almost taken to the extreme. The students were to learn to be industrious, methodical, self-disciplined and determined. That they also learned, as a side-effect, an "instrumental, pragmatic and calculative attitude to their environment", as Berner states (p. 86) was regarded as an asset – it was something that was required of the men who were to lead the nation to the brilliant technological future. Of course, these were all male characteristics, not at all suitable for women. Already the excessive work load could be seen as a sufficient reason to keep women out of the Institute. If it was excessive for men, how could it possibly be endured by the weaker sex?

Women were absent even from the leisure time of the students, from their gatherings and even their parties. The atmosphere was not markedly misogynous, but the homosocial environment gave the young men, out in the world for the first time and without responsibility for the last time, a chance to "play" together without the complications and restrictions that introducing the other sex would have brought about.

The students were in their early twenties or even younger. Most of them came from outside Stockholm, thus the peer group made up most of their social relations during the terms. Engineering students themselves created a number of rituals, many of them still surviving in one form or another. The studies were organised so that a class of students normally kept together during most of the education - and many continued to keep in touch after graduation. The social capital acquired in this way was considerable.

The societal gender contract, especially among the bourgeoisie, from where the majority of the students and teachers came, dictated a strict separation of sexes. Women and men were attributed very different characteristics - women representing beauty, morals, consolation, gracefulness and so on - and consequently different tasks in the society, leading to their exclusion from such localities as KTH.

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[4] There were a few women taken in by special permission. The first one was admitted in 1897. Architecture was the area where women were first allowed, and chemistry the second. However, they were very few in the beginning of the century - Berner mentions 6 students until 1917 - and by 1948, only 28 women in total had graduated from The Royal Institute of Technology (Berner, 1996).

However, Berner also suggests that a more deliberate exclusion of women from important societal areas was taking place, when commenting on the specialities which were deemed suitable for women: architecture, chemistry, physics and electrotechnics. For architecture there was a connection with homemaking, which was viewed as women's task. But the reason for letting women into the other specialities might instead have been, suggests Berner, that these were not very important or connected with status (for example, in the profession they did not imply such leading tasks as the other specialities often did). Besides, women might be seen as qualified aides to men in laboratories (women with lower technical education were used for such tasks).

The image of KTH at the turn of the century was thus to educate tough and disciplined men who were suitable to be leaders both because of their personal characteristics and because of their academic qualifications, which would widely exceed those of the men of practice from engineering schools at a lower level. This conception of engineers as being an élite group in the society has prevailed until today. However, when the social equality ideology gained ground in Sweden, it became important for engineers to gain some insight in the conditions of the working class. The Government Report in 1943 (SOU 1943:34) strongly recommends a period of work in industry before starting engineering studies:

> Fellowship with the working class is among the most important elements of this preparatory practice. Just as little as the engineer should be unfamiliar with the properties of machines and dead material, just as little should he as supervisor be unfamiliar with the characteristics of human material. He should know the latter as subordinate, equal and superior in industrial work. (SOU 1943:34, p. 108)

This ideology lives on in present-day engineering education, with its requirement of a period of work of 16 weeks in industry, in a subordinate position – something which is quite unusual internationally. It is called "factory floor experience" (for example Quality Review Committee, 1994), which implies its function as an "expedition to another reality" for those who will not share that reality in the future.

In a report in the beginning of the 1990s (Royal Swedish Academy of Engineering Sciences, 1993) the status of engineers was not stressed in the same way, even if the differences between master level engineers and other engineers were made clear. However, the conception of master's level engineering being an élite education is still alive both in the society in general, in industry and among the teachers and students in engineering institutions (Berner, 1992).

Scandinavian research on women and engineering education

Practically all Swedish research on gender and engineering education has female students and their daily environment in its focus (one exception are Berner, 1996, and Berner & Mellström, 1997), The interest in research on gender and engineering education in Sweden basically started to bear fruit in the first half of the 1990s, a decade after the first projects for recruiting women had been launched. In the first part of this section I will concentrate on this research and supplement it with a few American and British studies later. The aim of this section is to describe the basis for the reform work which is the object of my study, some general features from a gender perspective in the education which was to be reformed. When starting the reform, the team members naturally had the present education in the back of their minds and this section shows some of the gender problematics in this education.

Many Swedish institutes of engineering education have done some investigations among their female students. The most extensive is probably Agneta Göransson's (1995) report from Chalmers University of Technology. A smaller survey was made at the Royal Institute of Technology by Maj-Britt Hanström (1994). At Luleå University of Technology Trojer & Guldbrandsen (1996) researched the identity formation and working conditions of female graduate students and in Lund Institute of Technology, Silvia Sjödahl (1995) also made a less extensive investigation into the working environment of female graduate students. Olle Lagerspetz (1990) investigated the socialisation and identity formation process of female engineering students in Turku, Finland. A study on the culture of a computer science department and the way different student groups related to it at the Norwegian University of Technology was made by Bente Rasmussen and Tove Håpnes in 1991, and Eva Erson (1997) has investigated the language practices among computer science students and their exclusion of female students at Umeå University. These studies from Scandinavia in the 1990s all tell of a powerful socialisation process, through which female engineering students learn to accept the conditions set for them by the male majority during the educational process, and form a special identity where traditional femininity is looked down upon. It is not surprising that most of the female students are not capable during and after this process to provide the critique of the prevailing values and practices of the education which Rasmussen and Håpnes see as a condition for a change to happen at the university department.

Universities of technology as environments for female students

The characteristics of the education which, at the turn of the century, had as their primary aim to select a small amount of men to occupy the top positions in the male hierarchy, but which as a side effect also excluded women, still do exclude women. Officially women are now more than welcome into engineering, basically because they are a needed talent reserve - the men with the proper qualifications are scarce. But the reactions of women to the special features of engineering education are much more negative than those of the men. Göransson (1995) suspects that the image of an élite institution itself repels female students. (Linghag, 1996, in investigating secondary school girls' conceptions about another educational élite institution finds that it probably is so.)

According to Lagerspetz (1990), women who choose this education in spite of its sometimes repulsive image often do it because of their interest in technology. He finds that the male students generally have a more instrumental attitude to their studies, seeing it as a way to a well-paid career (this is also described by Kvande, 1984). He also finds that instrumentality is encouraged during the education (for example by the means of time pressure), and to some degree is adopted even by the female students - in case they do not drop out. His results are contradicted by Rasmussen & Håpnes (1991), who find that teachers at the computer science department encourage students who get absorbed by the computers and see the female students' "instrumental" attitude to their studies as a deficiency. In both cases the female students are deviants to a norm which is adapted in the first case to the male majority and in the second case to the hacker culture, which Rasmussen & Håpnes find to be the norm-setter at the computer science department.

The disciplining by time pressure is thus one aspect of the educational sphere which disfavours women. Curriculum content is another important aspect, by mainly relating to male experiences, by showing minimal interest in social sciences and the practical and societal implications of technology and by treating the subject matter as unconnected course contents of a few weeks' duration. However, Rasmussen & Håpnes (1991) find that female students, when getting involved in educational questions, do not question the curriculum content, but make suggestions about teaching methods, which are experienced as far too anonymous, ineffective and generally unpedagogical. While Rasmussen & Håpnes confirm the problems with the teaching methods, they also explain the concentration on these aspects by a hypothesis that the apparent satisfaction with the curriculum content actually masks an incapacity to conceptualise another kind of curriculum content, because there are no opportunities during the education to question the transmitted view of technology as the only possible one.

Berner & Mellström (1997), in analysing engineering as a masculine profession, write about male homosociality. Even if there are different groups among men (the three groups of male students Rasmussen & Håpnes, 1991, found in their study are a good illustration), there is also a "male collective" from which women are excluded. The opinions of this male collective were divided when women first entered engineering, and not so few advocated the exclusion of women. In the Swedish society of today such argumentation is no longer passable. Instead, the male students can exclude the females inside the frame of the educational institution. According to Erson (1997) this is done, among other ways, by daily linguistic practices. Humour is one of them, witnessed by both Göransson (1995) and Erson (1997).

In computer science both Rasmussen & Håpnes (1991) and Erson (1997) find powerful masculine dominance. Rasmussen & Håpnes show how the somewhat extreme values of the hacker minority group are accepted and transmitted by both the teachers and their favourite students as the prevailing values of the education and because female students' values are often rather the opposite, female students are marginalized, even if the hackers' values are not sexist per se. Erson, on her part, finds clearly sexist practices in addition to the problems caused by the prevailing values (evident in the expected working habits) and the exclusion caused by the male homosociality. Erson shows how male stereotypes of women (as subordinate and as sexual objects) manage to survive unaffected among the male students in spite of female efforts to bring them closer to reality. Erson also finds that teachers do not intervene with this kind of behaviour, but rather unreflectingly encourage it by objectifying and stereotyping women in their teaching. Rasmussen & Håpnes (1991) find that a small but influential group of men set the norms at a computer science department, and that the majority of male students, who actually have common interests with the female students in opposing the extreme values of the hacker group, confirm to these norms instead of supporting the women in their concern for the education.

The answers from female students about how they react to different types of discrimination are various. Many of them state that they have not noticed any discrimination or that they do not care. Others say that they adapt their behaviour somewhat to male expectations in some instances, to be able to get their way in others. What kind of answers the researcher gets seems to a certain degree to be dependent on the research method and the depth of the contact between the researcher and the interviewees - the better the relation between the researcher and the interviewee and the better the researcher knows the daily environment of the students, the more often she can hear about gender discrimination, it seems. Discriminatory experiences are not always related directly, but rather implied in different anecdotes. The interpretation of most of the researchers is that the women are prevented from seeing men's dominance exactly because the men in the educational setting set the norms for the behaviour of the women and these certainly include not bringing up gender issues. Thus, gender issues are absent both from the general discourse and from the sphere of interest of most female students.

Engineering education as an ordeal

Research from outside the Scandinavian countries in general confirms the same picture of the marginal status of female engineering students. Here I choose only to refer to the investigations of Hacker (1989), Seymour (1995) and Seymour & Hewitt (1997) because they, in addition to describing the current practices in engineering education and their effect on female students, also shed more light on the implicit the reasons for this practice.

Seymour & Hewitt (1997) interviewed 335 students, both male and female, currently or formerly enrolled in engineering. Their point of departure was to find about the reason for female attrition, but their results explicate several characteristics of engineering education which, without being overtly discriminating, affect male and female students differently. Some aspects which are only hinted at in the Scandinavian research are expressed more clearly in their report. In general their results are well in accordance with the Scandinavian ones, in spite of differences in the society and educational systems between the two geographical areas.[5]

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[5] The one main difference is that female students found the time pressure less disturbing than the males in Seymour & Hewitt's study, while the time pressure is one of the major concerns of female engineering students in the Nordic studies.

The vaguer dissatisfaction with engineering education found in the Scandinavian reports is named as impersonality and lack of support by Seymour & Hewitt (1997). They find out that what female students expect of their teachers is more of a personal attitude, which is more important than even pedagogical excellence. At the same time Seymour & Hewitt show that the withdrawal of support is an inherent characteristic of engineering education. They interpret this as having its origin in the function of the education as a rite of passage the young men.

Seymour & Hewitt (1997) find several characteristics of engineering education which remind of other rites of passage between boyhood and manhood in different societies. It is a matter of an ordeal. The withdrawal of nurturance, forcing the boy to become independent from his mother and from grown-up support in general is an inherent part of it. The concept of challenge is another. Belonging to a new community after the ordeal is still another. Seymour & Hewitt find all this in engineering education. It is regarded as tough. In the initial stages weed-out pedagogy is common, with harsh teaching methods, high curriculum pace and a merciless assessment system - only those who manage the ordeal with no support are allowed to pass through. Seymour & Hewitt found that the concept of challenge was a central one, when teachers were talking about their students and their teaching. Already in the later stages of the education the teachers and the students form new and closer bonds, and once through the education the student is taken up in the collective of engineers. Seymour concludes:

> A relatively small number of inexperienced young women are encouraged (with little prior preparation in the cultural and personal dimensions of their undertaking) to venture into an institutionalised national (possibly international) teaching and learning system which has evolved over a long time period as an approved way to induct young men into the adult fraternities of science, mathematics, and engineering. (Seymour, 1995, p.459)

According to Seymour & Hewitt (1997) the function of the education as a rite of passage was semiovert to the male students, but totally incomprehensible to the women. The women reacted with a feeling of discomfort which for several led to their eventually leaving the education, while the men endured with the prospect of being part of the engineering brotherhood later on. The even more distinct rite of passage in Sweden, *nollning,* has been discussed even from the viewpoint of female students. It seems that those students who stay on the education view nollning positively, or as a hardship where social benefits were more important than the discomfort. (Hanström, 1994; Göransson, 1995) However, Marinussen (1990) found that for those female students who had left engineering studies, the social rituals of the introductory period had been a contributing factor.

Seymour & Hewitt (1997) point out that the practices which the covert function of engineering education results in are not beneficial for male students, either. With respect to learning engineering, the pedagogical practices advocated by the female students would be better even for many of the men. Rosser (1996) points out that just improving teaching or changing the contents of the curriculum to place technology in its social context may actually advantage men more than women - only if the reform consciously considers gender, should it be expected that it will be good for female students.

An important contribution of Hacker (1989) to the study of gender in engineering education is her argumentation about the connection with the military. She starts by stating that the military historically plays an important role in the hierarchies among men and the subordination of women. She then shows how engineering education not only had its origins in the needs of the military but how one military engineering school shaped all engineering education in the USA in the nineteenth century. Hacker writes about the educational ideals at West Point (originally imported from France), which produced effective and well-disciplined engineers, well sought after both by industry and other engineering schools. The ideology was not only to impart engineering knowledge, but to discipline and mould the young men to loyalty to authorities, to discipline and to self-control. West Point graduates with their ideology had an important impact in forming engineering education in the whole country. West Point as a military institution naturally was for young men only, and civilian engineering institutions saw no reason to be less so.

Even Swedish engineering education has its origins in the needs of the military. The direct connection to the military was weakened during the 19th century and was no more obvious in the beginning of this century. However, the ideology which Hacker (1989) describes at West Point is also described to some degree by Berner (1997) concerning KTH. Besides, the Swedish reformers of engineering education at that time made study tours both to France and to the USA - the ideologies of engineering education were somewhat international already at that time.

The task of recruiting more women into engineering education in this perspective means taking women into a system which both historically and currently has a function of strengthening a masculine identity and male bonding. It is not surprising that the female students experience problems with their environment. By their mere existence they disturb the system - they contradict the function of the education as creating masculine engineering identities. Naturally, it should be possible to create an engineering programme which does not have this underlying function - but it is uncertain whether it is possible to create such a programme if the context is an institution which as a whole still adheres to the ideology of supplementing the engineering fraternity with new members.

Changing engineering education to recruit more women

Tapping the reserve of girls has been the most pronounced impetus for the efforts of recruiting women into engineering. When women are let into technical jobs it is because there is nobody else. More often than not they are met with resistance from the men in the workplace because of the breaking of gender boundaries

When, some twenty years ago, the scarce number of women at the universities of technology became a concern for society, active measures were suggested in order to increase their numbers. At the same time, what Hirdman (1987) would call the "feigned problematizations" in order to preserve the gender conflict in risk started to appear.

The most common of these was problematizing the women, which resulted in a vast number of projects trying to inform girls about the advantages of technical studies. When these girls made a rational choice and came to the university, the problem would be over. It took some time before the idea that there might be something wrong with the universities of technology themselves seriously came up. It was time to pick up the technique of looking down on the female students. They were, and are, seen as in need of help to cope with above all the social climate on engineering education. They need extra support, one has to be nice to them. That these "weak" females are a group quite as capable of coping as the males, but losers in an institutional power contract, is an idea that has not been formulated.

The third of the techniques is re-defining the problem. The problem has been placed outside the sphere of the universities by asserting that the problem belongs to lower levels of the educational system, which fail to arouse girls' interest in technology. When the problem is seen as belonging to engineering education, too, it can be narrowly defined - for example as being only of the beer-drinking practices or teaching methods. Making changes starts easily from an all-win perspective and seeking the benefits for both men and women become the main ambition, rather than change in gender relations.

In general, accounts from efforts of attempted curricular change for the benefit of women in universities of technology are quite scarce. The main means of recruiting more women into engineering are still intensifying the information about technical education, targeting women in particular, and stressing the aspects of the education which are expected to be attractive to them. Changing the curriculum for the benefit of the women is a new approach, and while there are some reports of what has been done (Lewis, 1993; Fish, 1995) it is difficult to find documentation of the results of the reforms.

Both curriculum content, teaching methods and the prevailing culture in engineering thus need to be changed if the education is to be made attractive to women. There are hardly any comprehensive reforms where all these aspects are taken into consideration. Reform efforts in any one area are in most cases so recent that it is yet to be seen whether starting to break the gendered traditions in one area will spill over and cause changes in other areas, too. The difficulties often encountered in making gender reforms even in a restricted scope seem to confirm that their dissemination to other aspects of education will not be very fast.

3. Gender och gender contracts

In this chapter and the following one the very basic concepts of gender and gender contracts are presented and discussed. As they are in no way simple concepts, there is a need to elaborate on them to some degree. At the same time the elaboration should connect with the aim of the study - looking at change in gender contracts in engineering education. That is why change in gender contracts and survival of gender contracts is given special attention. But this chapter starts with a very general background about the different streams feminist research has been divided into. This study is a drop in one of those streams.

A choice of perspectives

When talking about feminist perspectives on education, it is first to be remembered that feminism has many faces and uses different points of departure. Three "traditional" strands of feminism can be distinguished: liberal, radical and socialist feminism. These three are, to a higher and higher degree, supplemented by postmodernist and poststructuralist analyses.

Stromquist (1990) and Acker (1987) make a review of the perspectives the three feminisms have offered in educational research:

1) Liberal feminism is the approach most often used in the political discourse, and it also lies as a basis for much of the research about women and engineering education (Henwood, 1998). This perspective lies as the basis for the equal opportunity debate. It concentrates on individuals' possibilities and choices and on discrimination. The basic idea is that when there is no discrimination and all individuals have equal opportunities, the remaining gender differences depend on the individuals' private choices. In relation to engineering education, the research has concentrated on finding out why women do not apply, if the women who apply have some special characteristics, and whether there are instances of overt discrimination in the education. Researchers taking on these issues are now often approaching the other two perspectives (Acker, 1987).

2) According to radical feminism the inequality between women and men is explained entirely by men's power to dominate over women. Acker (1987) states that the two concerns of radical feminist educational research are the monopolisation of knowledge by men and daily interactions in educational institutions in which the dominance of men is clearly visible. As for engineering education, a sub-

stantial part of the research deals with the classroom climate in institutions of engineering education, even if that research does not explicitly take a radical feminist stand.

3) Socialist feminism acknowledges the power difference between men and women but also makes use of theories with a neomarxist background. Not only men's dominance over women is interesting, but also the institutions which at the same time structure other power differences in the society. As for educational research, this perspective connects to reproduction theory, trying to explain how education not only reproduces differences between classes, but how it also reproduces women's oppression. Studies of engineering education seldom take this stance – it can rather be found in the overall feminist research on gender and technology, where the perpetuation of the relationship between the two is one area of research.

Henwood's (1998) article is one rare example of post-structuralist analysis of engineering education. Henwood is not content with any of the perspectives above, finding that using only individual or structural factors does not allow "women's agency to be fully understood" (p.35). She uses discourse theory to go from individual discriminative experiences to showing how these take place in a certain discourse, which, to some degree is decisive for them.

My study is most closely related to socialist feminism. Acker (1987) asks for more research on higher education from a socialist feminist perspective, and I believe it is needed also for engineering education as all the studies of engineering education which take the liberal feminist perspective, and the policies grounded on them, leave very much of the problematics unexplained.

According to Acker (1987) socialist feminist educational research has two problems: it is deterministic, and it is not concrete. By taking its point of departure in reproduction and explaining different reforms as just another way of bring about this reproduction, it automatically casts suspicion on all efforts. And, according to Acker, the theoretical underpinnings of reproduction are difficult to prove in empirical studies, which makes socialist feminist research quite distant and academic. Acker agrees with Culley & Demaine[6] by suggesting "concentrating on specific struggles and practices in schools and local education authorities where outcomes depend on an array of influences, some under teacher control, rather than external forces alone" (Acker, 1987, p.428). That is the content of my study; concentrating on the struggles of two reform groups in two institutes of engineering education and describing their struggles to reform engineering education with the means under their control, but affected by external forces.

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[6] Culley, L. & Demaine, J. (1983). Social Theory, Social Relations and Education. In S. Walker & L. Barton (Eds.), *Gender, Class and Education*. Lewes: Falmer.

Thus, I can agree with the critique that the socialist feminist approach does not fully account the potential for change (Acker, 1987), and not even for women's agency (Henwood, 1998), and I hope to be able to step outside my frame of reference to even incorporate some of these. But my basic view of engineering education is that of reproducing a male élite, and it is this view which guides my investigation.

However, this investigation is situated in a liberal feminist context. The Swedish policies for increasing the percentage of women in engineering education have traditionally had a liberal feminist approach, trying to remove the barriers for individual women and trying to affect their choices. For universities of technology it is difficult to get outside this frame of thought, even if the task were reforming the education. One important aim is still affecting the choices of individual girls, by offering them a prospect of an education which is supposed to attract them more. It is still supposed to depend on the choices and abilities of the individual females whether or not they choose engineering and how they succeed.

Education being in some basic sense "gender free" (Houston, 1996) once instances of discrimination have been removed is one of the cornerstones of liberal feminism and a view which affects gender policy in institutes of engineering education. The education is not thought of as one which was originally attended by men and is now extended to women (Martin, 1991), but as a gender free education with some masculine details remaining from the times when women were even more scarce than they are now. Houston (1996) shows, with examples from public schooling, how gender free coeducation can actually strengthen the inequalities between the sexes, as the male dominance is given free rein under the guise of equal opportunities.

Thus, I am trying to set a socialist feminist perspective on a reform effort made in a spirit which is mainly liberal feminist, believing in individual choice and individual ability in a tradition which for a long time has believed in basic gender freedom of engineering education.

Gender

"Woman" has been shown to be a problematic concept, and there are many opinions as to whether and how it should be used. As Saarinen (1989) points out, woman can both be a concept that tells something about essential characteristics of one half of humanity, with connection to biological differences, or it can be regarded as a concept which in itself is meaningless, and only one expression of the power which one half of humanity exerts on the other. In the latter case "woman" can be seen as a prescription for these individuals assigning them proper behaviour, proper attitudes, proper biology and expressions thereof - all implying servitude to that part of humanity which is described by the concept "man".

In either case, humanity is in a dichotomous way divided into two groups, women and men. One main (and maybe one of the most fruitful) feminist critique of Western scientific thinking is the critique of thinking in dichotomies. The criticism of thinking of women and men as two distinct categories has its roots already in 1949, with de Beauvoir's "Le deuxième sexe". The understanding that most of scientific (and everyday) thinking follows a dichotomous pattern has illuminated both the fundamentality and the deficiencies of this categorisation.

As Alway (1995) points out, the dichotomising principle has also hampered social research in that it leads into looking for single causes or power relations with two poles, one with and one without power - an image of men having all the power and women being without. Furthermore, dichotomous thinking overemphasises the differences between groups and does not account for the intragroup varieties – even if differences between individuals and groups of individuals of either sex are often more important than differences between sexes. Social agents are seen as possessing a characteristic or not - for example social theories can regard them either rational or emotional (an example of Harding, 1998, offering a gendered division), not seeing their actions as simultaneously both rational and emotional. Areas where dichotomic thinking obscure the vision are manifold.

According to many feminists (Hirdman being the most important in my context) one important problem in dichotomic thinking is that it automatically implies a hierarchical ordering of the two categories - rather than two different phenomena, there is always a norm and an exception. Women and anything associated with the feminine are regularly the exception in mainstream science and theorising.

Defining and describing the dichotomising principle in social research and everyday thinking has been one important area of feminist social research, as have been the efforts to shatter this intellectual closure in feminist theorising. However, as Alway (1995, referring to Snitow[7]) points out, feminist theorising, because it is essentially linked in to the feminist political project, has always had to balance between two essential needs: on the one hand the need to make the idea of "woman" and "female" visible and give it power, make it something to be taken into account, to eventually make "woman" equal with "man", and on the other hand the need to disturb the common images of "woman", tearing down the ideas of women's "special" characteristics, deconstruct the dichotomy where "feminine" is one of the categories.

The need to both construct and deconstruct the concept "woman" reaches out to another important area of feminist theory building, elaborating the fact that being a woman, is a social construction. There the ambition has been to show the innumerable social processes where conceptions of what it means to be a woman are produced, reproduced and defined - and how the power balance is affected or is not affected in these processes. An early representative in Scandinavia was Haavind (1985), who argued that gender was wholly culturally constructed – and that gender could be constructed in every social situation, that the whole of our cultural code is gendered in its totality and in its particulars.

"Gender" is an academically created concept, which in Swedish official discourse is increasingly used to substitute "woman" (Jónasdóttir, 1998) - even if there is a growing body of research on the male gender and masculinity[8]. In parallel to "woman", "gender" is often used to describe special characteristics of (most often) women. And in parallel to "woman", "gender" can be used as a falsely unifying concept - even if it has arisen among feminist thinkers and the intention is not to prescribe servitude for one part of the humanity and power for the other. Gender can be seen as a composition of characteristics constructed and attributed in social praxis.

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[7] Snitow, Ann (1990). "A Gender Diary." In Hirsch, M. & Fox Keller, E. (Eds.), *Conflicts in Feminism*. New York: Routledge.

[8] In the following I also will in part write about gender as if it were a concern of and about women, and in that way subscribe to the traditional way of writing about gender. Naturally, men and masculinity are just as important for understanding the gender game. However, the analyses of men and male gender have this far been fewer than analyses of women and female gender, and so offer fewer theoretical grounds for me to build on.

This gender concept is attributive, and has to be elaborated according to the ideas of several feminist theorists who find gender to be relational. That is, gender is not something attached to an individual, but something that only exists in interactions between individuals. While I agree with the basic idea, I find it difficult to see gender as entirely something in-between individuals. As a possible standpoint I use West & Zimmerman's (1991) "doing gender", which seems to give a possibility of both attaching gender characteristics to individuals and an openness to seeing gender working and being constantly created in interaction.

West & Zimmerman (1991) stress that gender is neither connected to biology, nor an intellectual construction, but is created in societal, interactional praxis. Gender creates differences among men and women that are "not natural, essential or biological", and these differences are created in doing, not in thinking. An individual "is" not of a certain gender, neither does she "have" a certain gender, but she "does" a certain gender. Gender is created in the socialisation process of childhood, but also in interactions among grown up women and men. Praxis concretises, stabilises, and opposes the existing gender imagery. Gender is something that has to be learned, and it is learnt by doing - often without much reflection on the part of those who are born with the right biology corresponding to the gender they are to learn, but with more or less effort, if their biology and the gender they want to do not coincide. Practically all social interactions are doing gender to some degree. However, it is not only the strength in the doing of gender that varies; gender is also done in many ways, and these ways intersect with the ways of doing ethnicity or social stratification, for example.

In Sweden, the English "gender" is translated with a Swedish word "genus". As Jónasdóttir (1998) asserts, there are differences between these concepts. One of the earliest Swedish researchers to define "genus" was Yvonne Hirdman, and her concept "genus" means something more abstract and symbolic than the "socially constructed sex" of individuals. For her, "genus" is understood as

> changeable figures of thought, men and women (where the biological difference is always utilised) which give rise to or create perceptions and social practices, with the result that biology can also be influenced/changed. (Hirdman, 1990, p.7)

Thus, basically, "genus" for Hirdman is more a way of conceptually organising the world and an origin of social practices than a result of them.

In present-day Swedish research dialogue "genus" is often used as a direct translation of "gender". I am doing it the other way round: in this English text, the word "gender" is rather used in the way Hirdman uses it - as figures of thought which create social practices.

One bridging concept between "changeable figures of thought" and social practices is that of "gender scripts" - ideas of the appropriate for the different sexes and their relations. In social interaction these ideas become embodied in individuals of the two sexes, define their identity and direct their actions - become their socially constructed sex.

It can be discussed how inevitable it is that individuals should behave according to their gender script, and, above all, how inevitable it is that they should be deemed according to how well they manage to hold to their gender script. As Jaggar (1983) and Hirdman (1988, 1990) observe, praxis does not only change the gender divisions; as part of the psychological constitution of individuals, it also changes the physiology of human beings. Furthermore, Thurén (1991) states, on the basis of anthropological research, that there are societies where there are more than two gender categories, even if "women" and "men" usually are two of them. The discriminating characteristics are often, but not always, connected to biology, and defined in different ways. As gender seems to be a transformable concept, in constant processes of change, do gender scripts really matter?

A dividing line can be seen between the presumption that whatever an individual does, she is always seen in gender terms, and the presumption that there are many ungendered areas of activity and that individuals are sometimes seen as gendered, but quite often not - that is, whether individuals are first and foremost women and men, or whether being a woman or a man is just one of the characteristics of a person. Seeing gender, as I do, as the very basic category in the symbolic organisation of social life, the conclusion is that whatever an individual does, her gender script is fundamental (though not decisive) for the way her actions are viewed by others and herself. West & Zimmerman (1991) state that "Insofar as sex category is used as a fundamental criterion for differentiation, doing gender is unavoidable"(p. 32).

Thus, instead of gender being a characteristic of women, what women do becomes female gender - and female gender, rather than male, is what women most often do. A very basic example of doing gender is what Magnusson (1997) calls "sociability work". That is, taking care of the informal social relations and the well-being of the co-workers at the workplace, both psychologically and practically (being a listener and bringing flowers for the lunchtable). For example, among engineering educators and students it is agreed that it is nice to have women on the premises. Magnusson finds that "sociability work" is one of the tasks women commonly are socialised to do - and to be identified as women, they have to show some talent in it. At the same time that task is not valued and does not give rewards either in money or in career prospects.

Another example which can be used when discussing engineering education and gender is the concept of "responsible rationality" (Sørensen, 1982). Its contrast "technical limited rationality" can be found in Ve, 1994. These concepts are used theoretically to explain patterns in what women and men do[9]. Technical limited rationality at work limits itself to the task at hand, and seeks to find the most rational way to do it, regarding efficiency, cost-effectiveness, stated quality criteria and so on. Responsible rationality is especially used when working with other people, and seeks to solve given tasks as rationally as possible, regarding the well-being of the other person as central, and relating the other criteria to that. Technical limited rationality works with, and is probably developed by working with things rather than people, even if it is used in our society when deciding (for example in the public sector) on the fulfilment of human needs. Women more often than men work with caring about other people (both in the private and public parts of their lives) and "responsible rationality" is used to explain the way they do gender by choosing this kind of tasks and by the way they do them. "Technical limited rationality" is a concept to explain, correspondingly, some of the ways men more often than women act in their public and private lives.

Even if these concepts are not used in the public discussion about the lack of women in engineering education, much of it discusses the "new values" which women are supposed to bring with them into engineering, and which will cause women to do engineering in a new way.

Rogg (1991) refers to Bourdieu, who finds that women in general are allocated the repetitive and less valued tasks, while men keep those which are more dramatic and transient. These tasks are also the invisible ones (like "sociability work") and often mean responding to the needs of other human beings. It is in this kind of tasks that responsible rationality is needed and developed. Tasks are both allocated and chosen, as are ways of relating to them. Ideas about gender play an important part in both the allocations and choices – and make women, for example, choose engineering education less often than men do.

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[9] These concepts are related to the ideas of Gilligan (1982) on the ethic ot rights and the ethic of responsibility.

Discussing gender in this way dichotomises the image of the human race into men and women. However, there are good reasons to be constantly reminded of the fact that gender is not a unifying concept. At the same time, as Ve (1995) points out, there are also good reasons to sometimes analytically pretend that gender does exist and is, basically, connected to the experiences and lifeworlds of the two sexes. Not all women do primarily female gender, not all women are oppressed rather than oppressors. But in our society it is still evident that most women do primarily female gender and that these female characteristics are valued lower than the male and give fewer rewards in societal interactions. To be able to effect change in this state of affairs, the dichotomous way of seeing gender, even if inadequate, still seems to be the best tool invented this far.

Additionally, as Hirdman (1988) states, because our society is grounded on dichotomous thinking, the power struggles are conducted between members of dichotomous categories and the differences between the categories are used as weapons. To stop using gender differences as arguments in, for example, the equality discourse, requires that some other weapons be found – or that feminists manage to change the basic premises of the discourse altogether. That has not happened this far.

Following the argumentation of Ve (1995) and Hirdman (1988), in this study I use the concepts "men" and "women", "male" and "female", and "masculinity" and "femininity" in a dichotomous manner. The concepts *men* and *women* refer to the everyday categorisation of people, where the biological sex is combined with a gendered psychology and interaction patterns. In the lifeworld which the reformers and I, as well as most of the members of our culture share, there actually seldom is any doubt on how a person should be categorised in this respect. The concepts *male* and *female* as used in this study are, adjectives referring to the categories of men and women. That is, "male" refers to what men are, do and have - at least to a greater extent than women. The concepts of *masculinity* and *femininity* refer to the more abstract "figures of thought". That is, "feminine"[10] is connected to ideas on what is essential or desirable for the implicit conception of "woman".

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[10] Consequently, "masculine education" is not only education where there are many men, but also an education which confirms and advances such characteristics which are seen as essential and desirable for the idea of "a man".

Gender contracts

What is a Gender Contract

Another tool that is needed for feminist analysis is some kind of idea of the workings of gender in the whole of the societal context (Saarinen, 1989). It is in the context of such a system that both the openly discriminating and the seemingly neutral mechanisms and incidents on the institutional and individual levels can be problematized and those mechanisms which, under scrutiny, are found not to be neutral can be explained as something other than single instances which could be blamed on individual agents. A gender system theory seeks to analyse the structures and processes which transform what in our society is a difference in the biological reproductive organs into power differences between men and women, representing male and female gender.

One way of conceptualising gender systems is the idea of gender contracts.

Gender contract theories imply that the subordination of women occurs in mechanisms which are perpetuated by both women and men. Men and women have "contracts" on how gender is to be done. Gender contracts are primarily about power relations, disguised in many different kinds of "regulations". The way gender, femininity and masculinity, are constructed is fundamental for defining the power relations between women and men, and the power relations form men and women as agents (Holter, 1997). The contracts are not made by two equal parties; rather they are defined and imposed by those who have power, that is the men. Yet, women follow them not primarily under threat, but because they agree to follow them. And they can, ultimately, disagree to follow them and try to change them to ones which are more advantageous for them.

Sandra Harding (1986) has a widely cited theoretical frame for dividing the workings of gender into three societal spheres: gender symbolism (general ideas of masculinity and femininity and their relation to other spheres of life), actual divisions of labour in the society at large and in its different institutions, and individual gender identities and prescribed behaviours. These three support each other, but there are also tensions between them. Thus gender symbolism, what we call masculinity and femininity in a very wide sense, supports and is supported by the societal processes resulting in different tasks and rewards, and the individuals' conceptions of themselves – but never without complexities, the fit is not perfect. Other factors (for example technical development) affect the division of labour, making changes that go against common conceptions of gender. Moreover, individuals will not always conform to the behaviours prescribed by gender symbolism - there are both tomboys and sissies. So gender symbolism is not static, but is changed little by little by negotiations and struggles between men and women, masculinity and femininity. Since the seventies the general ideas of masculinity and femininity have changed a great deal, even if the basics would still be the same.

In Scandinavia an influential theoretical frame has been that of the historian Yvonne Hirdman (1987, 1988, 1990). As to the societal levels on which gender is at work in different ways, her theory resembles that of Harding (1986), but she has a more elaborated description of the principles behind the system.

Hirdman (1990) relates the concept of gender contracts to that of Habermas's life-world - interpersonal agreements on perception of the world (combined with values and principles for acting) that makes it possible for individuals to understand each other's experiences and interact; that is to say, makes social life possible. One of these agreements has to be how the differences between men and women are to be viewed - and for our dichotomic thinking it is natural to separate men and women into two poles. Given that dichotomic thinking automatically means thinking in norms and exceptions, this will apply to sex differences too. Why just male, and not female, has become the norm is a question Hirdman does not believe we will be able to answer. She just states that the agreements exist and that men are seen as the norm. And because these agreements are a part of the life-world, fundamental to the functioning of social life, they are also an important factor in all historical (and social) processes. The conceptions, expectations and understandings are transformed into practice, regulating the behaviour of men and women and institutions built up by men and women - and normally being further confirmed by this behaviour.

Hirdman's (1988, 1990) starting point is the two conditions that she regards as the prerequisite of male dominance in society: 1) Separating the sexes and 2) The normativity of the male.

Separating the sexes refers to the fact that male and female are separated as to their characteristics, tasks, and localities. Males are not allowed to exhibit characteristics considered female, do tasks considered female or be in localities or positions ascribed to females, and vice versa.

> Type 1 makes object 1 in place 1; type 2 makes object 2 in place 2; because type 1 makes object 1, type 1 becomes type 1: If one is at place 2 one makes object 2 and is a type 2 etc. (Hirdman, 1990, p. 11)

The normativity of the male refers to the circumstance that the characteristics, tasks and localities of men are always seen as the norm while those of women are seen as an exception to the male norm. The male is consistently valued more highly than the female.

These two principles manifest themselves in different ways in different contexts, and it is these manifestations Hirdman (1990) calls gender contracts. Following Habermas, Hirdman distinguishes gender contracts on three levels: 1) The cultural overlay - the overarching conceptions of male and female prevailing in society, 2) The institutional level (the social integration level) - conceptions of gender prevalent in different societal institutions (in a broad sense of the word encompassing, for example, both family and an industrial company as well as a university of technology) dictating, for example the division of labour, and 3) The individual level – conceptions that regulate the interaction between individuals and are a basis for the individual's identity formation, the level where socialisation into gender roles takes place. (Here Hirdman is very close to Harding, 1986.) Of course, these levels constantly interact.

Hirdman's conception of gender contract thus refers to the implicit structure of conceptions, expectations and understandings that regulate the interaction between people. Gender contracts are not drawn up in any distinctive manner, but emerge from human interaction, and it is through ongoing human interaction that they are negotiated and transformed. But the negotiations are not conducted between equal parties. Men who are the norm have been able to enforce contracts that are advantageous for them to a higher degree than women.

Change in gender contracts

By following the gender contracts the parties continuously reinforce the two principles of separation and normativity of the male. A major part of these contracts is transmitted from generation to generation; the system is self-sustaining. That there is a power conflict inherent in the contract is normally disregarded.

Hirdman's description of the gender contract has been accused of being static, and in its original version it is. However, later, Hirdman (1990) has stressed the continuous negotiating over gender contracts. Even if the basic abolition of masculine domination still seems to require a fundamental change in the very basic figures of thought, minor changes are taking place all the time. Even the weaker party in the negotiations does its best to turn the contract into something as advantageous as possible. As the system is a process of continuous defining and reinforcing of behaviour and expectations rather than a static structure, there is room for redefinitions caused by other changes in society.

According to Hirdman (1990), in order to make major changes in the gender contract system, at least one of the underlying two principles must be violated. The principal way to reform gender contracts is to violate the basic dichotomies in human thinking and doing, thus undermining the very principle of separating the sexes. According to Hirdman, this can happen for example when women for one reason or another are forced or allowed to perform men's tasks or establish themselves in men's locations, or when men and women for some external reasons are pushed together. War is a common example of the first-mentioned and Hirdman uses the French and the Russian revolutions as an example of the second. However, in all the examples, after the disruptive period life most often goes "back to normal", with the subordination of women. The temporary change in the separation of sexes has not been permanent.

In addition, gender contracts can change because of other changes in the society. Technical development, economic development or changes in the organisation of the society and its institutions (Sundin, 1997) may also impede re-negotiation of contracts. Depending on the relations to other power systems in the society, changes in them (such as changes in ethnic relations or changes in economic power) may lead to changes in gender power relations.

Furthermore,, Thurén (1996) reminds us that the gender system has inherent tensions and contradictions of different kinds. There can be contradictions between the different levels (for example between the societal equality ideology and the genderized division of labour or the ideology at an institution), between different structures at the same institution (such as Johansson, 1997, shows in contrasting the numerical female dominance and the increasingly masculine governing values of several public sector institutions), between contracts on different areas (for example between educational institutions and the labour market) and so on. Contradictions may open a change for re-negotiating the contract.

However, gender contracts are tenacious, which can be shown, for example by the studies made for Kvinnomaktutredningen[11] (for example Sundin, 1997) and by Jónasdóttir, 1991. Johansson (1997) suggests that changes be thought of in a perspective of several (institutional or biological) generations. There can be changes in the outlook of the contracts, but the basic power aspects may still stay the same.

An example of a hidden gender contract is the official Swedish all-win discourse, where gender equality is depicted as something that both men and women should desire and work for. In the current Swedish discourse it has become problematic both to admit being subordinated and to admit being dominating. This ideology places men and women together on the same side, against the obstacles on the way to equality, instead of confronting each other with the possibilities and limitations they are writing in the contracts. Pincus (1997) points out the usage of the concept "obstacle" in equality work as something concealing plain objection and sabotage on the part of (most often) men. Pincus attributes this to the reluctance of both women and men to admit the power difference.

Jónasdóttir (1991) also criticises the conception of genders as complementary when embarking on gender equality reforms. Far too often, she finds, this results in men defining new positions of women so that they become useful for men in new ways. Women are encouraged to enter into male-dominated areas to demonstrate the official gender equality at the same time as men in those areas keep the right to decide how a woman's actions and her very being are to be interpreted - feminine or not, "belonging" or not (Haavind, 1985). The official aim to achieve greater gender equality in an organisation can mask other aims which actually lie beneath (Pincus, 1997). Being involved in such a project, women (who most often conduct this kind of efforts) are supposed to keep within certain limits, not risking the original aim, but making believe that equality has been enhanced. One of the new tasks connected to the female gender, according to Haavind, is to make believe that the new forms of subordination lie in the interests of women. The reluctance on the part of the women to acknowledge the power differences embedded in daily practices signals successful gender socialization.

Thus, gender contracts, defining tasks, locations characteristics etc. of the two genders have changed and do change constantly. In Thurén's (1996) terms, the range of gender contracts especially has changed in the Swedish society during the last few decades, more and more areas having become acceptable to both women and men. What is shown in the examples above is that obvious change in the range *of the contracts* does not necessarily imply a shift in the hierarchy, the female gaining more status and power - even if the current Swedish equality politics seems to expect so. First, the separation of the sexes often continues in other, more subtle ways. Second, changing the power relations in this way is a two-step process: changing the range of the contract means changes in the separation of the sexes which in turn, but only if the change is big enough and perpetuated, should, according to Hirdman, lead to a change in power relations.

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[11] Swedish State Reports on "Women's power"; that is the position of women in the Swedish society.

4. Examples of gender contracts on three different levels

This chapter gives quite an extensive exemplification of gender contracts on different levels - it serves both as an exemplification and as a basis for understanding what happened in the reform projects. Knowing about gender contracts in organisations in general and in higher education institutions in particular gives a background in understanding why the reform teams in their organisations went about the reform work the way they did. Seeing how gender contracts on the individual level influence the identity formation gives an idea of how female reformators perceived their position and tasks in the team. And knowing about the overarching cultural gender contract which defines technology as a masculine area gives an idea of the deep-laying complications of the task these reform teams were to carry out.

Institutional level - gender in organisations

Women and men in organisations

The middle level in Hirdman's array of gender contracts is about the organisation of gender roles and working tasks in different contexts where people work together. Organisations are such contexts, and academic institutions and university departments are a kind of organisations. Reform groups, meeting regularly and having a certain task to carry out, are such contexts too. There has been quite an amount of research on how gender contracts take form in organisations, and I will refer some of it, where I find it relevant for the scrutiny of a gender reform of an educational programme made by a working group in an educational organisation. To this end, finally, some specifics of gender in academic organisations are also related.

My basic perspective is that gender is not only something which operates in organisations; it is also created in the organisational life. This is explicated, among others by Harlow & Hearn (1995), who relate gender to different organisational theories and show the inadequacy of organisational theorising when it does not consider gender contracts and the production and reproduction of gender in organisational life.

In the course of life in an organisation, implicit definitions of what it is to be a "woman" and a "man" are formed, reproduced and changed. Gendered patterns of conversation and behaviour become a part of the organisational culture. When organisational culture is described as shared assumptions, priorities, meanings and values, rituals, myths, stories, legends and rules (Harlow & Hearn, 1995), gender becomes a part of them all: assumptions of the "natural" characteristics of women and men, priorities concerning positions, economic means etc. held by men and women, respectively, meanings of behaviour exposed by female and male members, values deemed appropriate to the different sexes and legends from the history of the organisation as well as other stories and jokes where individual men and women play their parts and at the same time define a desirable and acceptable behaviour for their sex. It is in this kind of interactions that gender contracts are formed - describing what is appropriate for male members in the organisation but not for the females and vice versa, and thus enforcing the separation of the sexes. And more often than not, what is appropriate for the men is also what is valued in the organisational context - a situation which the organisational culture builds on, and which is therefore not questioned. The normativity of the male is carried on.

The approach of Harlow & Hearn (1995) also stresses that gender in organisations is not equal to the "woman question" in organisations and criticise the way even early feminist organisational research saw gender as a special issue:

> Within "functionalist perspectives" organisational culture is the female within the male. What this means is that both organisational culture and gender construction are other to the dominant, agendered organisation. (Harlow & Hearn, 1995, p. 187)

Instead, Harlow and Hearn see that just as gender is woven into the culture of the organisation, it is woven into its structures and daily practices. The daily practices are carried out by women and men according to changing gendered schemes. Positions are gendered, and power is distributed according to, among other aspects, gender.

However, the gender contract itself is often quite invisible for those working in an organisation. Roman (1994), in her study of knowledge-intensive enterprises shows how the masculine norm operates in a seemingly neutral workplace organisation. She shows how this organisational structure is created by and for male members, for example by assuming that working life is the primary concern of its members. Roman's primary finding is not that it is difficult to be a mother and a professional, but that seemingly gender neutral organisations assume that their members are male and are not even aware of this (as the managers in the organisations she studied were not), complicating severely the lives of female members. And when, consequently, the inherent masculinity is not paid attention to in the reforming of organisations and their modes of functioning (such as reforming educational programmes at a university), there is no reason to believe that they will make women less disadvantaged.

Another illuminating text about the unawareness of the inherent masculinity of the organisation is a Swedish governmental report (SOU 1994:3) about industrial leaders' conceptions of women and leadership. Several leaders of major companies were interviewed about the problematics of there being so few women managers in Swedish industry. Stereotypical assumptions about women showed up - not least the alleged lack of self-confidence. The report concludes:

> The report exposes a lack of knowledge, primarily among men, and a lack of dialogue between men and women in industry. Very few men at managerial level in industry have personal experience of co-operating with women as equals. Boards and management groups, as a result of men electing other men, are completely male worlds where the norm of the leader and the decision-maker being a man is constantly re-created. Men's conceptions of women and leadership is the greatest obstacle to developing a more even gender distribution among managers in industry. Knowledge is the key to change. Knowledge of the actual causes of women's underrepresentation must be found among the decision-makers who have the power to initiate change. (SOU 1994:3, p. 131)

The state report thus recommends increased knowledge of facts among the male leaders. However, facts, whatever there are, about women and men in organisations, can be of different kinds. For example, the tendency to see men and women as inherently different has sometimes been strengthened by organisational researchers who have looked at gender. The relationship between organisational research and women's roles in organisations is twofold: organisational research has defined female characteristics, either by the researchers' own characterisations or by reporting on the characteristics attributed to women by members in different organisations. But organisational research has also enforced these stereotypes legitimising them with scientific authority. So even feminist researchers' results have been used to allot certain roles to women, even when their original aim has been to emphasise the positive and beneficial aspects of "women's common characteristics" for the organisation.

> Women tend to judge themselves by standards of responsibility and care toward others, with whom affiliation is recognised and treasured. Women's moral judgements are closely tied to feelings of empathy and compassion for others, and more directed toward the resolution of particular real life problems than toward abstract or hypothetical dilemmas. Arising out of their experience of connection women's conception of moral problems is concerned with the inclusion of diverse needs rather than with the balancing of opposing claims. Femininity has been defined as receptive, nurturant, empathetic, intuitive, emotional, supportive, submissive.[12]

This list of female characteristics is not in any way surprising in itself. However, internalised by the organisational decision makers, it creates expectations of certain behaviours. By researchers posing questions in a certain way, many stereotypes become to have a scientific basis. This contributes to their being common in the general discourse and to their adoption by many people. The image of the caring, nurturing women with responsibility for all their fellow human beings is still common in the general discourse and this image can be expected to some extent to regulate both relations among faculty at technical institutes and their image of their future female students.

Tokenism

One of the basic and most influential theories about gender in organisations is presented for the first time by Rosabeth Moss Kanter in her book *Men and Women of the Corporation,* first published in 1977. Originally, she did not describe her theory strictly in terms of gender, but as pertaining to all groups of small numerical minority in an organisation. Later research (e.g. Yoder, 1991) has evidenced that the mechanisms she is describing specifically pertain to a small female minority in a male organisation - and can thus be expected to be at work at a technical institute. Kanter first stated that when women have less power than men and are marginalized, it is not a work of single men towards individual women, but a structural characteristic in an organisation which is always at work when there is a small minority group.

The concept Kanter uses is that of a "token" - which for my purposes can be said to denote one of very few women in a male organisation. The male majority is called "dominants" in Kanter's terminology. Kanter's three basic concepts of the token situation are visibility, contrast and assimilation: When there are few women among men, they are visible, observed and evaluated all the time. They are not evaluated like one of the dominants, but like one of a contrasting, totally different group. And to handle this situation their only possibility is to find a role which gives them a niche, a way to assimilate as these contrasting persons in the institutional context.

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[12] Cited in Alvesson & Billing, 1992, p. 74 from Ferguson, K (1984) *The feminist case against bureaucracy.* Philadelphia: Temple University Press.

The most conspicuous characteristics of a token is that she is a token of an "other", one who does not really belong to the culture, one who is disrupting. Kanter enumerates several characteristics of the token situation:

> Tokens are simultaneously representatives and exceptions. They serve as symbols of their category, especially when they fumble, yet they also are seen as unusual examples of their kind, especially when they succeed.
>
> Tokens are made aware of their differences from the numerical dominants, but then must often pretend that the differences do not exist, or have no implications.
>
> Tokens are among the most visible and dramatised of performers...yet they are often kept away from the organisational background where the dramas are cast.
>
> Tokens are the quintessential "individuals" in the organisation since they stand apart from the mass of peer group members; yet they lose their individuality behind stereotyped roles and carefully constructed public personae that can distort their sense of self.
>
> Tokens suffer from their loneness, yet the dynamics of interaction around them create a pressure for them to seek advantage by dissociating themselves from others of their category.
> As long as numbers are low, disruptions of interaction around tokens are seen by the organisation as a huge deflection from its central purposes.
> (According to Kanter, 1993, p. 239)

Kanter identified four ways of coping with the token situation, denoted as "mother, seducer, pet and iron maiden" (later more often described as queen bee). The most common choice for academic women who manage to make a career in the system seems to be to adopt the role of an "iron maiden", being regarded as some kind of half woman.

What is common to all token roles is that they are developed vis á vis the male majority and are dependant on their accepting and defining the tokens in this way. These roles define quite strict behavioural patterns for the tokens, patterns which often exclude them from much of the organisational behaviour (including those for gaining and exerting power) of the dominant majority. The appropriate role of the token is "more like that of audience than that of full participant" (Kanter, 1993, s. 226). She is unable to criticise the organisation and suggest any greater changes. She has accepted that femininity places her in a lower category than the men, and has either accepted being there or denounced her being a woman by trying to become like one of the men. Moreover she always needs to be guarded and careful about her self-representation among the dominants, as she can always be defined as something that does not belong to the context. Even if these behavioural patterns are not permanently fixed, they are internalised, and there are costs both for the individual and her social context if she tries to change her pattern.

The discussion on tokenism has concentrated on the effects of this situation on the token, rather than the effects of tokenism on the organisation, i.e. more on what it means for women to be tokens than what it means for the organisation and the organisational functioning to have such "distorted" relationships between men and women. The question of organisational reform is particularly interesting - as many of the tokens and the dominants have internalised the stereotypes and the behavioural patterns expected from the tokens, suggestions of changing the gender contract might arouse considerable resistance. The problematics are increased by the common assumption that it is women, that is, the tokens, who are the right persons to do the equality work.

Yoder's article (1991) criticised Kanter's view of tokenism as only being dependent on numbers. According to Yoder the question was not of numbers but of power - she saw Kanter's results as emanating from a situation where there was a minority trying to get into positions occupied and valued by the majority.

The view of tokenism as an expression of a power struggle rather than a structural phenomenon naturally changes the approaches for coming to terms with it. If it is a structural phenomenon, depending only on numbers, then, simply, more female individuals in one way or another brought into the organisation will solve the problem. But if it is a question of a power struggle, then increasing the number of women might just make things worse, as the threat they pose to the majority becomes more important.

In the 1993 edition of her book Kanter also finds that power is an important issue. She finds that possibilities for change are not very great. Changing gender contracts by just increasing the percentage of tokens meets several obstacles. To affect change in gender relations will need massive preparations and support on every level. Knowledge about the functioning and culture of the organisation is needed as the change will intervene in both. And even the reactions of the world outside the organisation need to be considered, to avoid possible backlash.

A threat for the token system are women who refuse to act like tokens, who actively and persistently oppose the gender contract of the organisation. Women who do this visibly are few - most of them adopt a token role or get out of the organisation again - but they do exist. And Kvande & Rasmussen (1990), as well as Alveson & Billing (1992) point out that the strategies of women should not be seen in black and white, but that even token women can to some degree use strategies to change the gender contract in the organisation.

Kvande & Rasmussen (1990) criticise Kanter and feminist research on organisations in general for their being static, picturing women as objects for male supremacy and not pointing out possibilities for change. Kvande & Rasmussen (and even Alvesson & Billing, 1992) point out that token women are individuals who have different characteristics and are situated in different environments with different gender contracts, and that they react to these contracts in various ways. As Hirdman (1988) says, in all gender contracts there are areas which can be discussed and disputed, and Kvande and Rasmussen state that women are constantly engaged in discussing, disputing and transforming the contracts, both individually and collectively. Kvande & Rasmussen find that change has happened, and new forms of gender contracts, unthinkable in the 1970s, can now be found in organisations, even if the basic token mechanisms are still often found.

Does balance in numbers change contracts?

The official Swedish gender equality politics sees breaking the occupational separation of men and women as the way to reach equality. The official doctrine is that once there is about 30-40% of the "underrepresented sex" (which is the official Swedish reformulation when gender issues are discussed) in an occupation, gender equality will be reached and the profession will be regarded as ungendered. That is the hope also in regard to engineering: once there are some 40% of women, engineering will no more be a male-dominated activity. Of course, that would even solve those of the problems of female engineering educators which emerge from their minority position. But looking more closely at the foundations of this hope, the solution does not seem that simple.

To start with, in spite of soon three decades of equality politics the professions where there is an equal number of women and men are few. The gender scripts do not encourage breaking the occupational gender barriers, and any affirmative action measures meet resistance. But even if the barriers were to be broken, the expected effect of non-genderizing a societal sector is far from certain. Sahlin-Andersson (1997) shows how, in cases of changed sex balance in a profession, the gender borders move into the profession - some professional activities come to be seen as feminine and others as masculine.

It is not only the occupational gender scripts which are expected to change when an occupation gets an equal number of women and men - another expectation is that changed sex balance will change the occupation itself (an expectation which is often referred to in connection with engineering). There is not much ground for these hopes either, which is shown by Johansson (1997) in her analysis of the Swedish public sector, in which health service and childcare in particular make an interesting case. As Johansson shows, in spite of its being women-dominated in numbers, the public sector is increasingly governed by technical rational values – even if the women in health and childcare occupations still often follow their gendered scripts of responsible rationality values and sociability work as far as the overall governing values allow them. This shows that the numerical composition of women and men does not decide the basic gender values of an occupation, as the two genders have different amounts of power. So, the efforts to change the numerical sex balance in, for example, a male-dominated area, even if they succeeded, do not in themselves threaten a masculine dominance on the level of gender symbolism.

Gender in Higher Education

The situation of female engineering educators seems to be well in accordance with the environments which Kanter (1993) describes. Universities of technology certainly are male-dominated institutions and what is said about the token situation generally applies even there. But universities of technology are special kinds of organisations, belonging to the sphere of higher education, and so the description can be specified to some degree.

There is a body of research on women in higher education institutions, and the marginalization they are subjected to, regardless of their subject area. Acker (1992) and Bagilhole (1993) give examples of tokenism in the academic setting. Hierarchy and competition are characteristic of academia (Acker, 1992; Norlander,1994) and these characteristics should be accepted by everybody who wants a space in the system.

Gender equality is on the agenda at all Swedish universities, and they all have gender equality officers and gender equality committees. Gender equality is incorporated in the bureaucracy. There are also individuals who have greater commitment in gender equality than the official policy. However, the results have been limited and there is quite a lot of resignation. The description by Farish et al. (1995) seems to be a case in point:

> Genuine equality of opportunity for staff (and students) often appears to be a combination of a chimera and the holy grail: unimaginable because there are so many different views of what it might consist of and unattainable because of widely differing opinions about how it might be achieved. (p. 185)

The different views of what equality might consist of almost always presuppose that gender equality issues are a problem area of their own. In practice no connection is made between equality and the quality of education and research according to two state reports (Ds 1992:119; Ds 1994:130). This is also true of the many projects at universities of technology to recruit female students (Ds 1994:130). Universities in general are eager to improve their gender statistics, but the reasons for doing this are not explicit in their efforts.

This might partly be because of a simplified understanding of what gender issues in higher education are really about. One of the state reports (Ds 1992:119) mentions the conception of gender roles, and this conception seems to lie behind much of the gender discussions in universities. (Yllö, 1989, finds it to be so in the USA.) Seeing gender roles as the crucial factor is easy in the individualistic environment of the university. As a contrast Ds 1994:130 writes about two levels on which working with gender reforms should be done: the individual and the structural level, which connects to Hirdman's (1990) idea of gender contracts on different levels. This state report asks for wider perspectives on gender equality by explicitly mentioning the issue of power relations.

The concentration on gender roles excludes insights on the way the curricula are genderised. The concern for recruiting female students and the questions about their lack of interest in technical education have substituted the more fundamental questions of the ways gender really operates in the environment and the subject matter of engineering education.

One further effect of the underlying conception of gender roles being the problem is that gender equity issues are regarded as women's issues which can and should only be taken care of by women. Hocking (1993 states that men should have responsibility for gender reforms in engineering education if there are to be any, and if the results are to be satisfactory for both women and men, as the reasons for the gender problems at an educational institution are depending more on the environment created by the male majority than the roles and preferences of the female minority.

An important group is institutional management, whose commitment is vital for realising gender reforms. However, a state report points to the decentralised structure of the universities and finds that the central management has difficulties in effecting change in the departments, if these do not consider the reforms important or essential (Ds 1994:130). Rather, the possibilities of the central management seem to lie in supporting and legitimising initiatives for change made on other levels.

Thus, the conception of gender relations being relations between individuals and the unawareness of the structural aspects curb the changes for greater gender equality. This is visible not least in engineering education. What is required is more knowledge of the breath and depth of the issue, committed institutional management and men who do not leave the reform work to their female colleagues. (Hocking, 1993; Ds 1994:30). Reforming an educational programme in particular needs to have support both from the institutional leadership and, ideally, from the students. It should take its point of departure in an analysis of the ways in which the present education and culture are masculine. And it should consider the reactions to the reform of the future employers as well as other important reference groups, such as other universities of technology.

Individual level - identity

On the individual level the gender contracts comprise the identity formation of individual women and men, brought about by interactions with other people. These interactions are, naturally, affected by both the gendered arrangements on the institutional level, and the common conceptions of gender. In the previous section the differences in the roles and tasks of women and men in male-dominated organisations, in higher education institutions, and in universities of technology were discussed. Those differences would imply that there are differences in the identity formation of the two sexes. This section looks particularly at the effects which these kinds of contexts can have on women's identity formations.

Women in male dominated academic organisations can be seen as to be adapted by necessity to the male culture, but they can also be seen as having some agency in transforming the culture. They can be the gravel in the machinery and with their existence they disturb the prevalent conceptions and practices. But the question is how much agency they do have. They meet with resistance from the outside and some of this resistance becomes internalised, as one of the female academics in Bagilhole's (1993) study expresses it: "I don't know what a woman academic is. Women are only seen as playing at being academics, not a real academic" (p. 441). The academic context affects women's possibilities, and it also affects their self identity. Wager (1994) suspects that when becoming an academic, many women have to construct themselves new identities for themselves, different from those of their female friends and family members, and that they then have to work with keeping up this identity.

Wager (1994) finds that this identity creates a difference between the women in the academy and the women they confront outside work. The academic women she interviewed saw themselves as having different identities privately and at the university, but their identity as academics was more important to them. They felt that the three concepts "feminine", "feminist" and "successful colleague" were separate and not possible to unite in the same person. They themselves would rather be successful colleagues than any of the other two. The findings of Lagerspetz (1990) point in the same direction. Lagerspetz interviewed both female and male engineering students, asking them to both define and evaluate the concept femininity, and found that female students actually viewed femininity more negatively than male students. Both men and women described femininity in approximately the same way, but while male students considered some aspects of it to be positive, female students considered traditional femininity as being almost totally negative. Lagerspetz interprets this as an identity crisis: Instead of there being a conflict between male and female roles in the educational setting this conflict is internalised in the individual women.

Apart from Wager (1994), even Acker (1992) and Bagilhole (1993) find that academic women in general do not identify with feminism. Bagilhole attributes this to token mechanisms: the fear of being identified as a woman. But it is also possible (as Acker seems to hint) that what these women know about feminism does not seem to address any problems they know of. As academic life is very strongly based on the ideology of individual prowess, factors which radical and socialist feminism point out are not seen, and the ideology of liberal feminism has not that much to offer to individuals who are generally regarded as having succeeded in their lives.

There is one more approach to studying gender in higher education, especially in engineering. Henwood's study (1998) confirms basically the general view of women in engineering education being marginalised, and especially their problematic identity construction, but she takes a deconstructive stand towards her data and chooses to see it as a product of discursive practices. She points out that seeing the identity formation of female engineering students as problematic implies an expectation that there is a more "normal" identity formation, instead of seeing that any identity formation is a result of the discourses in which it is taking place. Rather than departing from an implicit problem and locating it, as has been done in previous research in gender in engineering education, either in individual women or in the anonymous "structures", she wants to see how women are constructed and construct themselves in the different kinds of power relationships the production of which they are constantly involved in.

Mörtberg (1997) comes to a similar conclusion in her comprehensive study of female computer scientists' identity building. She finds the problem in the polarisation between male and female, technology and non-technology, where women have to take sides. This perspective, both in research and in the daily lives of these women, sees technology as already negotiated. Mörtberg would rather lift the process of negotiation, which happens among other things in these women's side-taking, to the foreground, dissolving the polarisation and accepting a view of both technology and gender identity as unstable.

Mörtberg (1997), Udén (1996), Henwood (1998) and Nyborg (1996) warn about problematizing the identity building of engineering women too much. There are all kinds of female identities, some of which include competence in technology and awareness of being in a male profession. Mörtberg criticises standpoint theories for essentialism. Even if they have a justification as a basis for the work towards equality between men and women, they do not really capture the situation of women in technical areas. Udén expresses the experiences and possibilities of these women as being "in between":

> If we are to recognise and express the entirety of who we are, it is mainly in the spaces in between that our presence exists. It is in the spaces, where male and female are imagined away or where reality is reconsidered that we can exist. (Udén, 1996, p. 60)

But can technology be changed from this position of in between? The possibility for change depends also on the historical situation - even if it is hard to say how a given situation will affect the gender relations in technology. The two World Wars make good examples (Nyborg, 1996). Even when women were allowed to have positions defined as technical and could show technical competence during the war, the definitions many times did not change, but the jobs were seen as naturally men's after the war. The question is whether what is happening in information technology is parallel to this, or whether substantial change is taking place. Mörtberg (1997) refers to the real possibilities of women for making careers in the area and, as the result of her study, finds that they can also resist and change the definitions of technology - even if she cannot say how big these possibilities are, just that they are different for women and for men. This far, she finds, an increase in the percentage of women does not automatically predict any substantial changes in the development of the discipline or the profession. However, female engineering educators engaged in gender reform may have an agency which goes beyond the pessimistic standard descriptions, even if this agency is certainly restricted by ideology, structures and identity.

Henwood (1998) states that unifying theories do not give room for the diversity which also exists among academic structures and academic women, even in the area of engineering. A more diverse view on female engineers' identity formation is presented by Kvande & Rasmussen (1990) who sketch four different ways for women to relate to their identities as women and as engineers at the same time. These ways result from different solutions to the problem of reconciling female values and engineering values, stressing the one and rejecting the other, rejecting both of them, or in some instances, being able to integrate them.

	Female values +	Female values -
Energineering value +	1 "Challengers" with both career and family	2 "One of the boys" competing with the men and themselves as different from other women
Energineering value -	3 "Compensators" – nine to five engineering, family rather than career	4 "Homeless" – insecure of their identity

Kvande & Rasmussen, 1990, p. 182.

The way female engineers perceive themselves and, accordingly, act in their professional and private lives is to a great degree dependent on their experiences in working life. The "homeless" are often in the beginning of their careers, seeking for their identity. They want to be regarded as colleagues on the same basis as men, and concentrate on doing their job well, but do not assert themselves. Most often they get dissatisfied with the positions they find themselves in. They are not conscious of the workings of the gender system in their organisation.

Other women compensate their dissatisfaction with their working life with paying more attention to their families. They can be previous "homeless" women who never got encouragement in their work and who have been more or less openly discriminated. Through their experiences they have gained an insight in the importance of gender in organisational life and have decided not to try to take part in the game, but to do their job and find more satisfaction in their private lives.

The women who have become one of the boys have adopted another strategy. They have fought their way into professional recognition, both by being excellent professionals and by asserting themselves. However, along the way they have noticed that they lose many of their relationships to other women and find it difficult to identify with women. They can be irritated especially with female engineers who adopt the "compensating" strategy, because they feel that those women who think that family is a priority are to be blamed for the discrimination all women encounter in working life.

The last group, the challengers, are professionals in good positions but also see their private lives and their experiences of mothering as an asset in their working life. They are professionally outstanding, and they have also gained an insight in the role that gender plays in organisations. They have developed strategies to be able to counteract the masculine patterns. They are the ones to introduce new modes of leadership and to question the prevailing values of an organisation. But from the perspective of Kvande & Rasmussen (1990) it is only this group which can be expected to really get engaged in changing engineering or engineering education. Thus, such women do exist, but not all women in engineering can be counted on as active in making gender reforms in engineering.

The cultural overlay level - gender and technology

Technology is Masculine in itself

The cultural overlay level, in Hirdman's model, refers to the general, often unreflected, conceptions of gender prevalent in the society. They are conceptions of women's and men's innate characteristics and conceptions about their proper places, tasks and behavioural patterns. One of those conceptions is the prevailing categorisation of technology itself as masculine. That conception is one basic reason for the difficulties in recruiting women into engineering, also to computer engineering. The very core of engineering education and the profession it leads to are technological and thus masculine. The impossibility of changing the technological content also makes for difficulties in changing the education to make it more attractive to women.

Computer technology is seen by engineering educators as something which should be appealing to women, as it does not require strength and is cleaner than building or machines. However, computer technology shares many characteristics of technology in general and is therefore just as appalling to women. Besides, there has arisen a very masculine culture around computers, which makes them even less attractive as a study object for women. The purpose of this section is to show the inherent contradiction in making computer engineering gender inclusive by showing how the very concept of computer technology in itself is masculine.

Sundin (1997) states the case plainly: in defining an activity or an artefact as technology, the sex of the people involved is of vital importance. First comes the gender coding, then the definition as technology or not. Taking examples both from the educational sphere she compares girls' and boys' use of technology, and finds that boys' but not girls' activities are labelled as technical.

Would it not be possible to change this and to reverse the process - first define technology and then, if it is unavoidable, add the gender coding? No, according to Sundin (1997). There is no such thing as pure technology. Technology is always imbedded in its social context, and most often it is a demonstration of men's power of constructing and implementing technological change. It is not possible to separate "male" technology from "neutral" technology, as technology, already during its creation is intertwined with male power. Wajcman (1991) adds that this male power is working in a patriarchal system, i.e. it is used by men to subordinate other men, and to subordinate women.

This naturally also applies to computer technology. Many women work with computers in different, but most often subordinate positions. However, those women are not seen as doing technical work. The possibility of using these women's everyday practical technical knowledge when improving computer systems is seldom utilised, even if this were possible (Vehviläinen, 1997). Instead, new machines and new systems created by, most often male, engineers are imposed upon them. Computers have become instruments of power, shaping the daily work, and more and more of the daily lives of both women and men.

Wajcman (1991) describes two kinds of masculine identity, connected to two kinds of technology. The common feature for them both is control and mastery. There is a practical technical identity; being able to repair and work on machines, combine physical strength with technical work, work with one's hands and get dirty. This kind of technical masculinity is prevalent in the working class, according to Wajcman. But there is also another kind of masculinity, that of the engineering profession, which places a greater importance on the mental control of technology, on theoretical understanding and the ability to create and control with the help of knowledge. Computer engineering is a case in point here, being strongly masculine in this sense.

Against this background it is easy to understand why the attempts to change the image of engineering education in order to recruit more female students have had only moderate success. The problem is not that the image is wrong, but that the image is quite correct and so the reality behind the image is wrong from a woman's point of view. Technology is not something neutral that has got a masculine image because it is men who do technology.

Technology is something that men do. To make technology something that women do requires more than efforts to involve more women in the practice of technology.

Thus, women in technical professions and technical education are a contradiction and a challenge. Henwood (1996), in interviewing both women who had chosen technical education and those who had not, found that especially those who had rejected technical education were well aware of this. They did not so much doubt their capacity for the job itself or reject the thought of dirt, noise and heaviness as they wanted to avoid the situation where they would constantly have to prove their right to belong to the environment. (Cwejman & Fürst, 1991, found something of the same attitude among Swedish schoolgirls.) The women in engineering witnessed that they had to do this much of the time, even when they wanted to gloss over the issue in the interviews.

However, in Cockburns (1991) words: "Just as there is no way back for women to nature, there is no way back for girls to 'people'" (p. 46). Women cannot avoid technology, they cannot avoid computers, but should gain power over them. But it can be questioned whether this can be done in the present educational and occupational structures. Elkjaer's (1989) suggestion is that:

> Instead of going into areas where we have no foremothers (role-models), that is in male-dominated areas of the labour market, we should insist on creating new areas combining what we want to develop (the general aspect of education and vocational training) with that which is unavoidable considering the political - and economic - climate (the technical part of information technology). (Elkjaer, 1989, p. 206.)

The uttermost consequence should be the re-definition of technology. It is unsure whether this is possible in an organisation the existence of which is based on the combination of technology and male power.

How about the computer?

From the above it should already be clear that what defines technology as masculine cannot be clearly stated. The masculinity is constructed in a social process where connections between technology-masculinity-power are created. In this process it is also possible for a small and smart artefact such as the computer and a quite abstract activity such as programming to be defined as masculine at the same time as they are coded as technology and realised as a source of power.

Lie (1996) makes an analysis of the computer as an artefact and finds that the object itself is not clearly gender-typed. It can be seen as masculine or feminine, depending on who is using it, where, and for what purpose.[13] There are no clear patterns among the users as to the gender-typing of the characteristics of the computer - different groups see different characteristics and evaluate them differently. The computer is a symbol of masculinity, but it is also a symbol of professionality, progress and independency, and that can attract both women and men. Thus, the computer in itself cannot be said to be masculine to the degree which would explain women's rejection of computer engineering. Rather, it is something in the context that repels women.

Mörtberg (1987) writes a short history of computing and finds different phases where women were excluded. As even computer scientists point out, there have been women in the history of computing. From early on women have shown that it is not an incapacity for the activities in the field which has kept them from the area. Although their principal task in the beginning was seen as operating the machines, there were women even among the first programmers, even if many of them are not visible in the history.

Mörtberg (1987) finds several factors contributing to the exclusion of women from computing. To start with, computers were developed for military purposes in military or paramilitary organisations. During World War II some women had access to these organisations, but many did not. Other computers were developed in a university context by academic mathematicians or engineers, of which few were women. Once computers came to be seen as an important technological advancement, these male actors engaged in more active measures to appropriate the area. Even in Sweden the military played an important part in the development of computers, according to Mörtberg.

In Metropolis & Howlett & Rota's (1980) collection of reminiscences from the creators of the first computers the ethos of absorption stands out. The different teams seem to periodically completely shut out the world and chase solutions to intriguing problems. The book gives an impression that at least the driving members of those teams would recognise themselves in the present-day hackers.

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[13] An example is Sundin's (1997) organizational study, where the CAD technology, when introduced in the National Land Survey became defined as female, much because it was situated in women's part of the office and to start with was used by the female map-drawers.

Maybe computers were also developed in a "wrong" historical era. While the first ones were created during World War II, the development speeded up during the 50's - a period when the ideology of the one-provider family and mummy-at-home was strong in the USA (Mörtberg, 1987). The newly established computer industry badly needed a competent work force, but during this period they only sought after young men with the right mathematical or engineering background. To employ women was against the common ideology.

The successful definition of computers as technology and programming as a technological activity has been very important for a certain group of men (Lie, 1996 and 1997; Nissen, 1996): the intellectual men who lacked the physical power traditionally connected with masculinity:

> With the computer, intellectuals have been given a concrete, visible and technical expression for their skills. Controlling a technical skill also brings them closer to "real" men in technical and manual work, while many in the latter group are becoming to resemble office workers. (Lie, 1997, p. 47)

From Lie (1996, 1997) and Nissen, 1996) it can thus be concluded that for this particular group of men it has been important that computers are seen as (masculine) technology. It has helped them higher up in a masculine hierarchy. Safeguarding this definition might be even more important because it could easily be challenged, as computing lacks several characteristics of "traditional" technology (Grundy, 1996).

Thus, the present definition of computing does not only keep women out, it also works on the hierarchy among men. In a way the effects on women can be seen as side effects of this function. Mörtberg (1987) refers to Pettigrew[14] about strategies which programmers around 1960 used to keep their status and privileges out of the reach of other professional groups. To stress their special status, programmers violated several norms and rules which applied to other workers. They asserted that exceptional knowledge in mathematics was a necessity to the kind of work they did, and that they had this knowledge. And they mystified their own working methods. All these strategies can still be seen in a larger scale as used in computer engineering and in computer engineering education. The hacker group of students largely gives the education and the profession its image (Rasmussen & Håpnes, 1991) and it is not effectively refuted by other agents - possibly because this very image enhances the definition of masculinity and thus the status of the profession. But this image also effectively shuts out prospective female applicants.

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[14] Pettigrew, A. (1973) Occupational Specialization as an Emergent Process. *Sociological Review, 21* May, 255-278.

Even if this "side effect" of positioning in a masculine hierarchy may explain some of the lack of women in computing, it is also possible to assert that there are more direct methods to resist getting too many women into the profession. Grundy (1996) gives several examples of this, from the difficulties in getting a welcome to female students into university prospectuses on computer science to masculine practices in the profession, such as the language used, the preference of esoteric solutions to practical problems or the indifference towards the female end-users of many of the systems. Nissen (1996) shows how an archetypical masculine activity, creating heroes and doing heroic work, is maintained among hackers. Lie (1996) counts control, mastery, challenge and culture as aspects which stress the masculinity of computing. Grundy points to the use of the word "engineering" in connection with computing finds that the usage of "engineering" to denote computing is in many cases a metaphor used to keep up the masculine definition of the field:

> However much the distinction between hardware and software is stressed, the practice of using the word engineering in the context of computing is like a marketing executive insisting on calling a product by a name that has consistently put off half the potential market, generation after generation. (Grundy, 1996, p. 89)

> This actually involves turning the status structure in the profession upside down; pure technical expertise will be regarded as a limitation rather than a sign of genius. This change will be fundamental for the profession and demands more than merely discussing use and consequences as a supplement to the technical aspects. (Bratteteig & Verne, 1997, p. 22)

Bratteteig & Verne (1997) are quite optimistic about this happening in the future. However, it is counteracted by many practices in the profession, also in the area of computer engineering education (Grundy, 1996). And given the assumption that it is of vital importance for men in the field to keep intact the partly esoteric computer engineering image stressing control and mastery intact for reasons of status and hierarchy, it is no wonder if transforming the education to make it respond to the requirements of societal orientation, connectedness and dialogue would require revolutionary changes. Changing the present professional definitions to the extent that would be required might be an almost insurmountable obstacle, and Elkjaer's (1989) suggestion of creating new professional fields would seem to be the only accessible, or at least an easier way.

Looking at Computer Engineering Education in Terms of Gender Contracts

A university of technology can be regarded as an institution with an institutional gender contract. The secretaries and administrative assistants are all female, as are cleaners and cafeteria personnel. In contrast, there are few female faculty members. The tasks, characteristics, localities, etc. of the administrative staff are defined in approximately the same way as is common for similar positions in other institutions. The female faculty, though, poses a problem.

The gender contract seems to be diversified here by the fact that the female faculty are often not regarded as "real women", either by the male faculty or by themselves.

Many of the female faculty and students express a problematic gender identity just because they are students or faculty at a university of technology. (Mörtberg 1996, Udén 1996, Nyborg 1996). This makes explicit the normativity of the male. The gender contract in society as a whole defines technology as a male task and a university of technology as a male location. Stepping inside the doors of the university thus implies breaking the contract. A way of maintaining the contract is to assure that there, in fact, has been no breach of the contract. This can be done, for example, by not considering the female students as "real" women. Of course they are women, but they are women basically different from women in the outside world.

Defining the female students and faculty as not quite female is one example of what Hirdman (1987) calls disregarding the gender conflict. This way, the gender problematization is located outside the university, and as to the women who come in through the doors there appear to be no problems. So, while the society as a whole may see these girls and women as pioneers and breakers of the gender contract in a male location, actually a special contract seems to have been created for them at universities of technology.

As students, the females have shown themselves to be quite as capable as their male counterparts and, even if there still are examples of teachers who do not believe in the intellectual ability of female students, the prevailing opinion is that they are intellectually up to the mark. These few special girls are actually supposed to do pretty well. They are not, however, expected to go into hard core engineering but, when given the choice, to keep to areas that are less of pure technology. In computer science, they are not expected to be as knowledgeable as the males or to be "hackers", positioning themselves in the computer labs more than is required to pass the courses. They choose and are expected to choose applications instead of pure technology.[15]

As to female characteristics, females are expected to give a human touch to the company and activities of their fellow engineers and scientists. They are said to be good with people and to have another way of looking at technology - two characteristics that the male faculty say they themselves are lacking.

So these women are given a half-way position. They are allowed to go deeper into the male area of technology and they are allowed to demonstrate more competence in this area than is normal in the general societal gender contract. This is because they are special, not quite women. But the most prestigious, innermost core of technology is still male. Females are welcome to participate in teaching and research, even if there is a common understanding that this can to some extent be restricted by home duties. They are especially welcome to enrich the work and the workplace with a human touch.

When not interfered with, the gender contract is quite self-sustaining in that female students very soon learn their position as half-females and also that it is best to adjust to the male norm. The message is: a university of technology is male, take it or leave it. Even if a few leave, very many take it and learn to like it. By graduation there is some pride in having made it – after all it means that one has achieved abreast with the males. It is common for female students to resist changes in the institution in favour of females - the argument goes that female students should not be spoiled but take the education as it is, because it is obviously possible for women to manage the studies and learn to cope with the men, most of whom are quite all right (Göransson, 1995; Hanström, 1994). Most of the faculty have been students themselves and seem to retain these opinions, even if the potential for change seems to be greater among teachers who have experienced and reflected more on the gender relations at the university.

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[15] Rasmussen & Håpnes's case study (1991) sheds some light on how this gender contract is mutually created and sustained at a department of computer science.

However, the gender contract among the faculty at a university of technology is influenced by the general gender contract in society. As long as technology in general is considered a profoundly male area there has to be some special contract for women in technical education and research. According to Hirdman, the way to change the gender contract would be to violate the principle of separating the sexes which, in this case, is not so much spatial as assigning different characteristics and, accordingly, tasks. As intellectual ability is not seen as a separating characteristic, the typically female characteristic has become the "human quality" of the women, expected to lead to interests in applications and contextual factors with respect to engineering tasks, and generally certain social preferences as to the daily life of the institution.

As long as hard core technology is an important source of male power in western society and, accordingly, as long as there are interests in keeping this part of the gender contract untouched, there are no reasons to either "dehumanise and technologise" the female or to emphasise the "human" qualities of the male in computer engineering education. However, the structures of high-tech industry might be changing, expecting more "human" qualities from the engineers and this may, in time, show in the education.

5. Reproduction and reform in higher education

This chapter looks at engineering education as a reproductive mechanism. The theory of Bourdieu & Passeron (1977) lays the foundation in seeing the concealed main task of education as the reproduction of the prevailing power structures in the society. It is further elaborated by Lundgren (1983), who takes a closer look at the autonomy of the educational sector and the two kinds of reproduction that result from it – the reproduction of work force (engineers) and the reproduction of the educational ideas and practices themselves. Whenever curricular change is attempted, these reproductive spheres interact, and those working with the reform are caught between their often different demands.

The work of Pierre Bourdieu

The work of Pierre Bourdieu about the reproductive functions of the educational system offers a language and a framework for placing into a larger context the educational practices and reform ambitions at universities of technology. While theories of gender in organisations, gender identities, and gender and technology increase the understanding of the different gendered interactional and contextual mechanisms in engineering education, the macro theory of Bourdieu & Passeron (1977) aids in formulating what these mechanisms amount to: the reproduction of the male technological élite of the society through the educational system, in this case through engineering education. What the reformers were supposed to change were deeply rooted reproductive patterns which did not lend themselves to reformulation in any simple way. Besides, the Bourdieuan concept of *habitus* comes in handy to describe the end product of engineering education.

These concepts appear but are not very distinguished in the book by Bourdieu and Passeron, *Reproduction in education, society and culture* (1977), where their theory of reproduction of societal power structures by education is presented and developed. The basic idea of Bourdieu's reproduction theory is that education is not primarily a functional way of imparting necessary knowledge to the population, but a way for dominant groups in the society to exert power. The way the educational system and educational practices are organised and the curriculum content are more or less designed to perpetuate the power of the dominant groups.

Supplementing this work with later expositions of Bourdieu's theories gives it more illumination. In this chapter I choose mainly to refer to the later works of Bourdieu through some of the interpreters of his theories.

At the time *Reproduction* was written Bourdieu did not refer to gender. The possibility of using Bourdieu in feminist analysis is discussed in the following section. Later, the concepts of habitus, capital, field and doxa are explained briefly, with some remarks about their relevance in engineering education.

Bourdieu and gender

Until the late 1980's Bourdieu himself seldom referred to gender. His theoretical frame has not, consequently, been used by feminists to any great extent. However, there are some who argue that Bourdieu's theories can be used in analysing the power relations between men and women, that it is possible to integrate gender in the Bourdieuan sociology, even if Bourdieu does not do it himself.

McCall (1992) gives two readings of Bourdieu in relation to gender. One of them is advocated by Bourdieu and one is not - but McCall finds the latter as a plausible development of Bourdieu's theory, and valuable in giving feminist research access to the whole of Bourdieu's theoretical construction. McCall also shows how Bourdieu's ideas on societal structure are comparable with those presented by Sandra Harding (1986) about the gendered structure of the society. This is explicated even more by Laberge (1995).

The first of McCall's (1992) readings shows that Bourdieu regards gender as an additional element in the positioning of individuals in societal fields. These positions are decided by the capital of the individuals, but this capital is realised in gendered ways. Other such "secondary" decisives are age, ethnicity and geographical place of residence. These "secondary" traits are hidden but real.

According to this first reading, gender is a relevant factor in analysing social structure and social reproduction - but it departs from Bourdieu's own analyses, which most often take occupation as their point of departure. This way of regarding gender does not allow for the potential for using Bourdieu's theory in the analysis of societal gender structures, which McCall (1992) still perceives there is. She wants to be able to import gender more to the core of the picture - and finds a way in Bourdieu's definition of *embodied cultural capital*. Capital is something individuals can use in their efforts to position themselves in relation to their fellow beings, and gender can be seen in this way: in a male-dominated society male gender is advantageous in several contexts, whereas female gender can offer an advantage in others. Gender is acquired through upbringing – thus gender is culturally mediated capital. At the same time the intimate connection between sex and gender makes gender an inseparable, embodied, sort of capital. Thus, McCall concludes, gender in itself is a form of cultural capital, which is acquired by socialization and valued differently in the different societal fields. She presents Bourdieu's example of female gender as an asset (in occupations based on beauty and charm) and her own examples of female gender as a deficiency (in male-dominated occupations).

Laberge (1995) builds on McCall's article, but gives a more pedagogical presentation of the parallels between Bourdieu and Harding (1986). While Harding writes about gender symbolism in the form of dualistic gender metaphors, Bourdieu also takes up binary symbolic forms of understanding which structure our knowledge of the social world, and of which the dichotomy feminine/masculine is one. Harding's gender structure, the gendered division of labour, would correspond to Bourdieu's occupational categories, which are affected by the division of labour by gender. (Here the parallel seems somewhat halting.) And Harding's individual gender identity, socially constructed, could be compared to Bourdieu's concept of habitus.

McCall's (1992) argumentation is interesting in giving feminist theorising an access to a new frame. Viewing female gender as one form of cultural capital illuminates the position of women in male-dominated fields, such as engineering. However, as a feminist researcher, I am prone to regard gender as something more fundamental than one special form of the four kinds of capital Bourdieu sees as basic. The comparisons between Harding and Bourdieu are interesting but neither McCall nor Laberge (1995) go deeper in their analysis in combining the two - which might be quite impossible from the starting point of regarding gender as one form of cultural capital.

In my analysis I start instead from another approach provided by Moi (1994), based on the concept of "class". Bourdieu, especially in *Reproduction* (1977) talks about dominating and dominated classes. Moi argues that these fundamental concepts can be translated into "men and women". The concept of "class" is quite vague in Bourdieu's theorising, which is why there should not be any hindrance to this. Brubaker (1985) relates the Bourdieuan concept of class to

> "class-based variation in the meanings and uses of nominally identical goods and activities...and especially to the class-based, systematically unequal distribution of the instruments needed to appropriate and accumulate both material and symbolic goods...This original class-based inequality engenders others: it leads in particular to class-based inequalities in the chances of realising material or symbolic profit in the various fields of activity - in school, on the job market, on the "marriage market", in one's everyday consumption practices - and in the chances of accumulating power in the form of material or symbolic capital. (Brubaker, 1985, p. 749)

As far as "women" is used as an analytic concept in a feminist analysis of society, this concept seems to correspond fairly well to the Bourdieuan concept of class.

Moi (1994) gives an overview and an analysis of applying Bourdieu in feminist research. Even if she finds that Bourdieu's concept of class can be equated with gender, she reminds us of the fact that "women" is a very wide concept and that just as "women" can be equated with "class", so can many other concepts, for example those having to do with ethnicity and age. She states that when analysing an individual woman's position, not only her sex but even other aspects have to be taken into consideration - especially because other categorisations in a certain situation may be more important than her sex. Even in engineering education it might be so that not all women occupy the same kind of positions, but that there are other discernible factors which further define their positions - or which may even be more important than their sex.

Actually, by the end of the 1980s Bourdieu himself explicitly theorised around gender in terms which would equal gender as one of the groups which could be denoted as class (Moi, 1994). Thus, for a feminist, Bourdieu can offer still another concept of gender with a theoretical framework around it - for example explaining the reproduction of gender relations through education.

Bourdieu's own analysis of gender relations is quite static (Moi, 1994) and offers practically no hope for this dominated group to change its position, as their *habitus* , their identity, behaviour and world view are determined by the power structures. A massive effort would be needed to change a sufficient number of the practices creating and reproducing this habitus, as gender is involved in so many levels and areas of societal life. Thus, Bourdieu seems to leave women in the lurch.

However, Moi (1994), in her account on Bourdieu and feminism, does not do so. She points out that the empirical material which

Bourdieu bases his gender theories on does not mirror the situation in the west in the 1990's. While Bourdieu presupposes unanimously accepted gender patterns, Moi points out that in the present Western society gender is questioned on several fronts. The keepers and defenders of the traditional roles are severely questioned, even if not always openly, by promoters of new ideas. Moi sees this as a possibility for change - gender relations in the society are not unquestioned everywhere and even if the massive efforts to change gender relations do not seem to be under way, changes have taken place and seem to continue taking place in practices which promote new gender roles.

Thus, even if Bourdieu can be seen as pessimistic, when trying to take the whole of gender question in one big bite, his theories can be used even by more optimistically oriented female researchers. This would even conform to his conception of the task of sociological research:

> I am not suggesting that sociology solves all the problems in the world, far from it, but that it allows us to discern the sites where we do indeed enjoy a degree of freedom and those where we do not. So that we do not waste our energy struggling over terrains that offer us no leeway. (Bourdieu & Wacquant, 1992, p.199)

Habitus, capital, field and doxa

In this study the concept of habitus is central. Engineering education is regarded as endowing its students with a certain kind of habitus. Several of its practices are seen as serving the task of habitus formation quite as much as imparting the knowledge needed for engineering tasks. The aim of the education is to mould its students, and the Bourdieuan concept of habitus comes in handy to explain what this moulding is about.

A habitus is always related to a *field*. Actually, Bourdieu himself states (Boudieu & Wacquant, 1992) that field is the primary object of social science, and that individuals are interesting merely as agents on the field. Still, the concept of field is not exactly defined. A Bourdieuan field most importantly implies a site of struggle over power positions in the field. Bourdieu compares the field to a game (Bourdieu & Wacquant, 1992), where the players have different kinds of capital as stakes and try to conquer good positions on the field. A field has some kind of borders, even if they are not defined, and an autonomy, in that the struggles are fought in the field and the proper recognition for the winners comes from other agents in the field and not from the outside.

A habitus is what enables an individual to take part in the game on the field. Brubaker defines habitus as "the system of internalised dispositions that mediates between social structures and practical activity, being shaped by the former and regulating the latter" (Brubaker, 1995, p. 758). If "social structures" are equated to "field", this means that activities within a field contribute to habitus formation and regulate the subsequent actions of the agent in the field. Habitus consists of dispositions for action and thought and is a competence for acting in the field, formed by the field (Broady, 1983).

The stakes used in the game on a field are different kinds of *capital*. Bourdieu discerns four basic kinds of capital (even if other designations of capital also appear sporadically in his texts): economic, social, cultural, and symbolic, which are weighted differently on different fields. In his empirical studies, innovative ways of defining and measuring different kinds of capital are used. Economic capital is normally measured by income and property - the sheer amount of money. Social capital denotes connections to people of importance or the preparedness to make such connections. Cultural capital in a strict Bourdieuan sense is connected to the French educational and cultural system and acquired by certain educational backgrounds, but is often widened to denote education and familiarity with established cultural institutions. The concept of symbolic capital needs some more expounding, as it is the most important form of capital touched upon in my analysis of gender reform in engineering education, and as it is the most vague of the four forms of capital.

Stated simply, symbolic capital is whatever is recognised and valued in a field. Broady (1989) uses concepts like credibility, respect, image, reputation, and prestige when explaining symbolic capital (p. 1). Brubaker (1985) finds the roots of the concept in the Weberian notions of charisma and legitimacy. Carle (1995) in a more "operative" definition states that "symbolic capital is those symbols and attributes an agent needs to master and recognise to continuously express her right to belong and her competitive ability" (Carle, 1995, p. 384). The concept of symbolic capital, though it is vague, is not undeniable, but needs to be defined for every field specifically. For example, because technology in our culture is perceived as inherently masculine, in technical fields such as engineering, symbols and attributes connected with masculinity can be expected to carry symbolic capital.

Much of a person's habitus is formed in the interactions within the field by the person learning to value her capital the way it is done in the field and to use it to promote her position in the field.

> ...the newcomer has made certain definite efforts and has allowed himself to be shaped so that he has become what he has to be to reside within [the literary] field: that he has learnt enough about previous and current [literary) feuds to be able to identify the right issues, that he has learnt to speak, write, behave in certain ways, got to know the right people.(Broady, 1983, p. 71)

It is an important feature of habitus formation that this is all taking place voluntarily and for the most part unconsciously on the part of the newcomer. A field may well have different procedures, initiation rites being one example, the function of which is to enhance habitus formation. Some fields have a stronger formative effect on habitus than others. One principal difference between the ordinary concept of socialization and that of forming habitus is the stress on habitus being not only a psychological disposition but to a great extent a bodily disposition. Habitus refers not primarily to the way people think, but to the way they act, not their psychology, but their whole being.

An individual's habitus starts forming in childhood, in what is normally called primary socialization. This habitus is the basis of later additions and reformulations, according to the fields the individual is engaged in, but the original social conditions (the position of the family and thus the individual in the societal field) are many times quite decisive for subsequent participating in different fields and thus subsequent habitus formation. The original habitus acquired as a member of the dominated group of "women" can also be regarded as enduring and decisive to much of the individual's later life.

At the time of writing *Reproduction*, Bourdieu seems to have regarded habitus as quite a rigid and unmovable structure. After being criticised for the problems of introducing change to the theory, Bourdieu modified the concept to allow for change:

> Habitus is not the fate that some people read into it. Being the product of history, it is an *open system of dispositions* that is constantly subjected to experiences, and therefore constantly affected by them in a way that either reinforces or modifies its structures. It is durable but not eternal!...Aside from the effects of certain social trajectories, habitus can also be transformed via socio-analysis, i.e., via an awakening of consciousness and a form of "self-work" that enables the individuals to get a handle on his or her dispositions. (Bourdieu & Wacquant, 1992, p. 133)

However, even if Bourdieu allows for the human psyche to gain insight without being determined by external factors, he necessarily regards habitus as very stable. It has to be; as it is the habitus of the agents of the field that carries on the traditions of the field, it is solely the habitus of the agents that actually keeps up social structures. (Brubaker, 1985). However, because habitus consists of dispositions and not fixed patterns, it is not static and gives a flexibility to adapt to changing conditions (Calhoun & LiPuma & Postone, 1993). And again, even if habitus can be flexible in regard to external demands, it is enduring, as it is downlaid in the body itself. McCall (1992) shows why the simultaneous flexibility and durability of habitus can make it a useful concept in studying genderized power structures:

> With respect to gender organisation and identity, two crucial components of Bourdieu's conceptual apparatus, *capital* and *habitus* , speak to a recurrent and puzzling feature of gender relations: the persistence of nearly universal and binary gender stratification accompanied by varieties and multiplicities of gendered identity in practice. (McCall, 1992, p.839)

A fourth concept which is relevant in studying the field of engineering education is that of *doxa*. Doxa is what is regarded as unquestionable and self-evident in a social context, presuppositions of the social actors which they are not even conscious of. A certain order of things is not seen as one of several possible alternatives, but the only one. A play for positions on a field presupposes doxa - a tacit agreement on what is valued. And habitus formation implies the inculcation of doxa, internalising an unexpressed world view.

Doxa does in part explain why the games in the fields go on. As it is unconscious and unquestionable, it is hard to change. Some kind of crisis is needed in the practical functioning of the field before doxa can be questioned and a field thoroughly changed. This can be brought about from the objective conditions of the field changing, and lead to some groups starting to question the bases of what is regarded as natural and normal. However, a crisis does not always work. To start with it leads to struggles over doxa - what is to be regarded as natural, normal and right - and as the positions of those who dominate on the field are dependant on doxa, they struggle to put everything back to normal. (Moi, 1994)

By using the concepts of habitus and doxa, both intelligible reform of the field and the preservation of unintelligible traditions by the same agents can be understood. The agents are not victims of social structures, but engaged in processes in the field, competing with each other, reformulating parts of the field to make the competition more advantageous for themselves - they have full agency to affect the structures. At the same time they have internalised the basic rules of the game and their basic concern is to keep the game going on. This is very limiting to what alternatives for action present themselves - most often only one or a few do so (Calhoun & LiPuma & Postone, 1993).

On reproduction

Berner & Callewaert & Silberbrandt (1977) give an informative account of the main features of Bourdieu's (or Bourdieu & Passeron's, as the main work on reproduction is written jointly by them) theory of reproduction through education. This theory examines the function of the public school system of perpetuating the dominance of the "dominant class" in the society. Thus, this theory deals with the school system as a whole and with class (even if the concept of class is not equivalent to the Marxist one), not with engineering education and gender. However, the four points in the theory, taken up by Berner & Callewaert & Silberbrandt, can be transposed to the situation of women as a dominated group in society being reproduced by engineering education.

The first foundation of the theory is exactly the assumption that the educational system supports the reproduction of certain power structures in the society through bringing about a certain distribution of cultural capital among its pupils. Bourdieu describes education as *symbolic violence*..

What happens in education, in Bourdieuan terms, is that individuals submitted to the educative process become endowed with (cultural and symbolic) capital useful in societal fields - this capital becomes part of their habitus. Through education the dominating class can transmit the knowledge, values, behavioural patterns (cultural arbitrary, in Bourdieu´s terms) to pupils who are unable to question this limited perspective of the world, as it is the only and legitimate one offered. Symbolic violence violates the subjects' world view by presenting only one perspective on the clashing interests of the different social groups, that sanctioned by the dominating class in their own interest. It is essential for the functioning of the educational system that the exertion of symbolic violence is not recognised.

In addition to stating that it is the dominating class which defines the cultural arbitrary, the cultural capital transmitted by the educational system, Bourdieu also argues that this capital is distributed unequally. Those individuals who belong to the dominating class, whose values are transmitted by the school, already have some of this capital in their habitus and are encouraged to grasp more of it. Those individuals who come from the dominated class find the habitus inculcated (a Bourdieuan term) by the school foreign and have greater difficulties in acquiring it, as the idea of the teachers is to, basically, treat all the pupils the same. Thus, individuals with a background in the dominating class manage to gain a habitus with much more capital, which consequently later puts them in a dominating position within the societal fields - and so the power structures of the society are reproduced.

The second point taken up by Berner & Callewaert & Silberbrandt (1977) is the autonomy of the educational system. This autonomy, they state, is essential in concealing the exertion of symbolic violence through education both from those who work in the system and from those who are submitted to it. The distribution of the cultural capital is made to seem natural and objective, as the power structures which it perpetuates are seemingly absent from the system itself. Not even those subjected to and deprived by the education can rightly assess their own situation - what they bring with them to the educational situation is given no value and thus their efforts are geared towards attaining the cultural capital which the education has to offer (or, if not, they become the outcasts of the system).

Thus, a habitus built on the values of the dominating class is made desirable for the dominated class - at the same time as it is unattainable for most of its members. This misrecognition is possible because the educational system, besides reproducing these power structures, also has a function of fostering basic cognitive abilities and increasing the knowledge base of its subjects, which is recognised and conceals the reproductive function. That is to say, what is visible is the work of the educational system to transmit to its subjects certain facts, and what is concealed is that "it is not enough to learn the facts by heart, they also have to be reformulated and used in a dialogue with the power that is the origin of their symbolic value" (Carle, 1995, p. 362). Another important factor is the capability of a certain number of individuals from the dominated class of attaining, against the odds, the desired habitus (Fowler, 1997). This makes it possible to refer to individual giftedness, rather than the class of origin, as the decisive factor in educational outcome.

The teachers are unaware of the reproduction of the power relations which their daily practices enable. In their daily work of teaching Bourdieu views them rather as interchangeable agents, employed by the system to guarantee its perpetuation. They have an acceptable habitus and see as natural the task of educating students to attain the same habitus.

Another aspect of the autonomy of the educational system, not highlighted by Berner & Callewaert & Silberbrandt (1977), is the difficulty of groups outside the educational system in affecting the reproductive process. Maintaining its own functioning is a basic interest of an educational institution. To this end the teachers and other functionaries are chosen, rewarded and punished, students are taken care of, resources and results are negotiated with the world outside, internal and external struggles between keepers of the traditions and modernizers are fought. To persist the educational institution has to answer to some demands from the outside - it has to take care of the societal task allocated to it. But at the same time the internal traditions of an institution - the educational system being autonomous - are strong. Even when facing new demands many of the internal traditions resist change.

The ideologies which are inculcated by the educational process and the relative importance of cultural capital allocated, as well as the power structures reproduced by the system are not created by the educational system, which is the third point that Berner & Callewaert & Silberbrandt (1977) take up. The task of the educational system is to educate individuals to a society where these ideologies and structures are prevalent and the existence and autonomy of the system are based on its fulfilling this task. The products of the system have to know their place in the existing power system.

The fourth point brought up by Berner & Callewaert & Silberbrandt (1977) considers the role of the family, or the correspondence of the knowledge base of children from different origins to the knowledge base required and promoted at school. The educational system presupposes certain behavioural patterns and knowledge base from the children, and those who have not acquired it in their family of origin, most often children from the dominated class, are disadvantaged from the start. Even engineering education presupposes a certain base of previous knowledge and behavioural patterns - most often acquired during a male adolescence.

Looking at engineering education with Bourdieuan eyes

If Bourdieuan reproduction theory is seen from a gender perspective, engineering education can be seen as used by a dominant group, men, in the society in perpetuating a gender contract which gives women a subordinate position. I view engineering education in the light of feminist research as part of a society where technical rational values (Ve, 1994) are cherished in the official discourses (which still for the most part are male discourses), and where technology is perceived as masculine (as is explained in chapter four).

Education in a technical profession which carries much of the status and power connected with technology perpetuates and recreates power relations between men and women and between different groups of men. That is, the professional group of engineers reproduce their culture and society by means of an education, which they quite autonomously govern. Even if engineering education is conducted in state financed institutions, the state seldom interferes with how they conduct their business. Engineering education is supposed to be improved by the institutions themselves, and reports about engineering education are normally written by a group of engineers rather than bodies outside the engineering sphere. Only faculty in universities of technology and, to some degree, representatives of technological industry have direct influence on the practices of engineering education.

While women were previously excluded from engineering education, first by regulations and later by signalling the masculinity of the education, there are now societal changes which serve to promote women's access to the education. The societal gender contract in Sweden has changed to the extent that the exclusion of women from engineering, as from other groups with power (such as politicians or industrial managers), has caused some concern. However, the solutions suggested have been to encourage women to apply for engineering education rather than questioning the pedagogical action which is excluding women.

This resembles the programme of "culture for the masses", which Bourdieu sees as perpetuating the power of the dominant class. It makes it possible for the dominated classes to appropriate the culture of the dominant class, instead of questioning the legitimacy of its dominance. Correspondingly, engineering in its present form, with its value systems, practices, and rewards, has been marketed to women without giving them a chance to comment on its legitimacy. This is what projects on "showing girls that technology is a good career prospect" are basically about.[16]

Encouraging women to go into engineering has, nevertheless, borne some fruit. The percentage of women in engineering education has risen, and gradually that will also increase the percentage of women in the professional body. However, this cannot unreservedly be interpreted as a proof that the male reproduction of the engineering profession with its status and power is giving way to allow women to reach the same positions.

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[16] The organization WISE, active in several European countries, takes basically this approach - and is criticized for it by Henwood (1996).

A greater number of women now go through engineering education, but many of them witness that it still favours male candidates and that the reproduction of values and behavioural patterns even transforms them to become more masculine (Kolmos, 1989; Lagerspetz, 1990; Göransson, 1995). Admitting some women into engineering may even serve to keep engineering a male dominated area. When there is a small minority of women, it may give the impression that the profession is open to both sexes and, consequently, reforms are not needed. In that way these women can contribute to the misrecognition of the reproductive role of the education.

The success of school education depends on the experiences the child has received at home, according to Bourdieu. In parallel, the success of engineering education depends on the experiences during the previous years of life. The differences in women's and men's approaches to engineering education can be attributed to differences in their experiences at home, and among their peers. One example is that girls to a greater extent learn to care for human relations, while it is more acceptable to boys to get immersed in their own interests without regard to social obligations - which is also what is often required of an engineering student.

According to Bourdieu, the agents for the pedagogical action are trained to reproduce their own training. This also applies to engineering education. Most engineering faculty are engineers themselves. It implies that they have not only endured the education, but adapted to it to the degree which is required to get good marks and be selected to belong to the faculty.

The institutional conditions which enable interchangeable agents to continuously carry on the work of schooling, as Bourdieu states it, are also visible in engineering education. After the process of selection into the faculty, there are several factors which make it much easier to teach the same way one has been taught oneself than to make reforms. Because of the lack of pedagogical education engineering teachers are normally equipped to teach only the way they have experienced as students. There are also several structural restraints. Recurrent features are for example the short courses which are studied two or three at a time and the fixed examination periods. There is a time pressure which restrains critical thinking. The premises are planned for teaching in big lecture halls and having individual laboratory sessions, and have to be booked long in advance. The career structure and the way of rising in the hierarchy encourage the devaluation of teaching commitment, which results in teachers following the laid out paths. Trying to keep to other ideas of education which might be left after the inculcation process of one's own schooling thus meets with several practical obstacles, and reproduction becomes almost the only alternative. And when it comes as far as reforming the education, the desire to keep up the basic game on the field plays a part. Agents for change, guarding their positions in the field, are careful not to recommend changes which would shake the foundations of engineering education, its ethos and practices.

Going through engineering education can be expected to build an engineering habitus, which is a prerequisite for coming out and being a worthy member of the engineering profession. What is transmitted by engineering education is, apart from competence in, for example, designing computer systems, also a complex of values which lie behind the idea of computer systems, their origin, usage, importance and future, and a complex of norms and practices, designating the appropriate behaviour, problem-solving habits, scopes of interest and so on of a computer engineer. The education inculcates in a selected number of men (and some women) certain schemes of perception, thought, appreciation and action, and creates a professional identity, a habitus. These schemes are to sustain later in the working life and include for example a competitive frame of mind, elitist thinking, creative and independent thinking and work inside given frames, an instrumental view on both materia and human beings, elegance instead of attention to particulars, and a working morale promoting absorption in given tasks (Hacker, 1989, Srivastava, 1996). The creation of a habitus is achieved explicitly, by the teachers talking about proper practice, but even more implicitly, the educational system in itself encourages some behavioural patterns and punishes others. The students are expected to make quite big investments in terms of time and effort, and they are not supposed to question the institutional practices which structure their everyday life.

Some of the characteristics of an engineering habitus are immediately relevant in the daily work of an engineer, while other aspects are not. However, several of them are precisely connected to positions of power in the society. These values and behavioural patterns are sought after, when leading persons in the industry are to be appointed.

The case of academically clever female students dropping engineering can be explained against the strong habitus formation of engineering education. Even if they have the required intellectual capital, their discovery that the field requires even other kinds of symbolic capital - interests, previous knowledge, toughness, competitiveness - which they do not have, or their unwillingness or incapability to integrate the doxa in their habitus, makes them leave the arena and find another context which better corresponds to their original dispositions. Bourdieu sees the problem in pedagogic work as that of being treating every pupil the same, irrelevant of her background, which gives an advantage to those pupils who are acquainted with the teacher's frame of reference. In engineering education there is a strong ethos of treating everybody the same - seen as a guarantee of fair play in the competitive environment.

Most of the time neither the students nor the teachers are aware of the moulding which takes place in their daily work. The scarce number of women among engineering graduates is not attributed to the reproductive function of engineering education, but women's uninterest in technology or, at the most, some practices which still regrettably exist on the education and which tend to repel women. And even those female engineering students who are critical of the value base of the education or the organisation of the studies, most often have not felt they can stand up and present an alternative - as they most often have not seen an alternative by the time they have proceeded in the system to the position where they could use their voice. Furthermore, when they express their insights they are seldom understood. Their doubts may imply a questioning of some of the doxa of engineering education - in which case it is hardly possible for the players in the field of engineering education to understand them.

Vertical and Horizontal Reproduction

Lundgren's model of two kinds of reproduction in education

The theories of Ulf P. Lundgren are connected to Marxist thought as well as the reproduction theory of Bourdieu & Passeron (1977). While Lundgren has been working on many areas of educational research, in this context his theories on power and control over curriculum planning (Lundgren, 1983) are most interesting. Lundgren elaborates the Bourdieuan notion that educational agents (schools as well as universities of technology) are autonomous. This state of affairs results in special problems in both change and the perpetuation of power relations.

What happens in curriculum planning depends, according to Lundgren (1983), on the relation between education and production, the power structures that are supported by the production system (for example the state) and the history and traditions of the educational sphere. These two elements of power can also be seen as contributing to the reproduction of gender contracts by education. The aims and means of the dominating gender are imbedded in the curriculum, and its manifestations. Curriculum is created in a discourse, mainly within the educational system, but framed by the claims and expectations of political power in society. When determined and implemented, the curriculum is normally not questioned by those subjected to the education. Instead, subconsciously but firmly, the subjects accept the definitions of reality, for example gender relations, transmitted by the educational practice based on the curriculum.

Lundgren writes about vertical and horizontal reproduction in education. Vertical reproduction refers to reproduction of the work force, that is, delivering the knowledge and skills that the individuals need as members of society and part of the work force. Lundgren gives four examples for the operation of vertical reproduction in education: 1) Supplying the students with knowledge and skills required in production, 2) Supplying the students with a moral qualification - for example punctuality, diligence, creativity, 3) Giving the students a certain identity, and 4) Creating employment for a certain part of the population - teachers.

Horizontal reproduction refers to the fact that education also delivers knowledge and skills that are not directly demanded by its societal task of educating the labour force but rather by its own traditions and structures.

When a curriculum, which normally makes for both kinds of reproduction, is created, two sources of power interact: the vertical power of production and society and the horizontal power of the educational system or institution itself.

Both vertical and horizontal reproduction have implications for the gender structure of engineering education. As to vertical reproduction, universities of technology have a very close relationship to the technological industry, a powerful sector of society which is almost exclusively male. As to the educational traditions, horizontal reproduction, these educational institutions were created at a time when engineers were male conquerors, not of new continents but of new technology, the new era, and the place of women of the same social class was in the home. Even if transformed, quite many traditions and practices from those days are still viable. And engineering education still contributes to the reproduction of genderized power relations by educating predominantly male students for a profession which often leads to positions with both influence and status.

Engineering education has quite a powerful socialising effect in forming the habitus of faculty and students. According to Lundgren, some features that form this habitus can be found and analysed in, for example, the curriculum of a study programme produced and used at the educational institution. A curriculum with history and traditions is normative to the extent that, for example, the underlying concepts of gender relations are conceived as the natural order and remain unquestioned by both students and faculty. Much of the curriculum is created or selected by the predominantly male faculty at the educational institution and codifies their often tacit opinions about the aims and content of the education. This may be even more true of the educational practice.

However, new demands in technological industry may require changes in the current engineering education in ways that also are related to gender.[17] Johansson (1997) suggests that the private sector in Sweden (employing most of the engineering professionals) actually values competencies normally regarded as feminine higher than the public sector (for example higher education) does. The task of supplying the knowledge and skills required in production is not performed quite as well as it used to be when many of the engineers find positions where proficiency in, for example, economics, communication, and personnel administration is vital. These areas of study, this far, seem to interest more female than male students. A moral qualification which is becoming more and more important in industry is the capacity and willingness to co-operate in a team. Current engineering education lacks training in this - something that female students have complained about more than the male ones. The identity provided by engineering education today is very much that of a technical expert, capable of interacting with objects, while technological industry seems to prefer increasingly engineers who see themselves as knowledgeable co-operators in different contexts where technological knowledge is sought for. The fixation on objects is also something female students of technology complain about, and the image of an engineer only interacting with objects is something that seems to restrain many girls from going into engineering education.

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[17] These changes are reflected on, for example, in Civilingenjörens yrkeskunnande, 1994, a book published by the Swedish Association of Graduate Engineers.

Thus, even if it lies in the interests of a male-dominated society to keep engineering a masculine field, the vertical power also seems to have pragmatic reasons for requiring the kind of changes in engineering education that might lie in the interests of women. The state, having pronounced a gender equality policy, also has some interest in raising the percentage of female students in engineering education. But the changes that are supposedly required to achieve this goal are met by the horizontal power, a male-dominated educational organisation with masculine traditions that raises obstacles to the realisation of the reforms demanded.

Central authorities and local arenas

Later, Lindensjö & Lundgren (1986) looked more closely at how the interplay between vertical and horizontal reproduction functions in the implementation of educational reforms. They study the secondary school system, but their findings seem quite applicable even to higher education. Their focus is on the relations between the central authorities and what they call the local arenas. They find that educational systems cannot be governed by a managerial approach - and this certainly seems to apply to the higher education sector (Barnett, 1994; Becher & Kogan, 1992).

According to Lindensjö & Lundgren (1986) the central authorities generally do not have knowledge of what the most impending problems on the local arena are, and yet, these local considerations tend to make up the definitive formulations of the intentions of the central authorities. If the justifications offered to advance a reform are not in accordance with the needs of those who are to carry it out, the reform is abandoned or redefined. Besides the effects that could be predicted with a better knowledge of the local arena, there are always accidental circumstances, concurring development on other areas relevant to the faculty members urging them to make priorities. In addition, the implementation process itself changes the agents. The result of central intentions is thus highly unpredictable.

However, sometimes the central authorities are not interested in what the results of the local policy implementation are as long as they just get something moving (Lindensjö & Lundgren, 1986). In those cases it is quite natural if the formulations of the initiatives of central authorities (especially as they in turn are results of conciliating different interests) often appear quite vague in their final form and leave room for interpretations. In controversial issues (such as gender) it might be a more or less conscious strategy from the part of the central authorities to let the ideological strides and problems be taken by the lower levels. Bourgeois & Nizet (1993) find that in legitimising a decision it is advantageous if it can be formulated so vaguely that different groups involved can interpret it in a positive way.

Even Lindensjö & Lundgren (1986) find vague formulations functional, as the goals and intentions of the central authorities are often over-ambitious from the point of view of the grassroots. When faced with tasks seen as impossible to carry out, the basic units and individuals, Lindensjö & Lundgren assert, choose to transform the goals to such which are seen as possible to realise at the same time as they are careful to pay lip service to the aims of the central authorities. Lindensjö & Lundgren see this as something positive, substituting unrealistic goals with more realistic ones, which better address the problems of those involved. They would give the individuals in the basic units the right to reformulate central intentions and decisions, because they see that compromising about central goals may make them easier to implement. According to them, the chances of successful implementation will probably be far greater, if the reform pays attention to the daily, concrete problems of the faculty members.

Aune (1995), in studying implementation of organisational change in several institutions of higher education, also finds that a recognised need for change among the faculty and the perception of the suggested change as being in accordance with their own interests is important for the implementation. According to her, faculty members' main interest is how the change will affect their working situation. Aune describes some of the different psychological forces which are at work in change processes: ambivalence, role ambiguity, uncertainty and the need for control, joys and fears connected to collaboration, and feelings of mastery and accomplishment and personal professional growth. These often direct the actions of the faculty members more than rational considerations.

However, allowing a generous reformulation of projects by local agents also makes for perpetuating practices and systems which, in a more general perspective, can be seen as undesirable. Herriott & Gross (1979) are more critical of the actions of the local level. While they see that the management approach of the authorities to the renewal projects they were financing resulted in several problems, they also think that the aims and intentions of the authorities were legitimate and could easily be redefined too much by the local school districts. Thus, for a satisfying reform there has to be a balance in fulfilling both the ambitions of the central authorities and the needs of the local agents, even when they differ considerably.

6. Method

Description of the method

In the autumn of 1993 I was a fresh graduate student at the Department of Education and Psychology. I was attending the basic courses of my graduate studies and working on a project for one of the professors. At the same time I was looking for a theme to write my thesis on.

My undergraduate examination thesis was an overview of female students on computer engineering courses and that was one of the areas which interested me. I had also made a short dive into women's studies. Another of my ideas was to look at the documents (of which many were produced at that time) relating to the university reform and find out about gender aspects. However, when I saw a short notice in our University paper, I realised that I might have found the theme of my thesis. The notice was about a professor who had received a state grant to create a new computer engineering programme, one that would attract female students. As I had found in my overview that hardly anything about female students in computer engineering had been written from the perspective of the educational system and the teachers, I believed I could make a contribution. My idea was to follow the planning work of the new programme, and my original research question concerned "the image, the conception of a female student" in the head of a faculty member of a university of technology.

There were no problems of access. After an initial contact with the professor in question, who was positive to the idea, I set about designing my study. The planning work was about to start practically immediately, and I was invited to the first meeting, to present my idea and tell the group what I wished of them. I felt (rightly or not) that I should follow the process from the very beginning, and so I made a design in quite a hurry, relying on what I knew of qualitative research methods from my undergraduate studies. In the first meeting, in the beginning of 1994, I presented my overall research question and asked if the group would accept 1) me observing and tape-recording all the meetings and 2) being interviewed three times in three years. After some discussion about the tape-recording the idea was accepted.

I had expected observations to be my main data, and thus started collecting a sizeable amount of taped planning meetings. However, it soon became evident that overt references to gender were quite scarce in the team meetings. My design was failing, as I was not getting the kind of data I had expected. In contrast, my first round of interviews were a positive experience and gave me better data than I had expected. So my emphasis shifted from observations to interviews.

In connection with the discovery that gender was seldom discussed in the team meetings, another question started to intrigue me more than the mere conceptions of female students: why were there so few references to gender, what was actually happening in the meetings? That became the focus of the study. The reformers' perceptions of female students became only one of the research questions, supplemented with the reformers' attitude and interest in gender issues more at large, gender relations in the reform group and the influence of the institutional context on the reform work. Interviews were to be an important part of the data, because it was through them that I could get an idea of how the reformers themselves viewed the situation. It was only for one of the research questions, the one of gender relations in the research group, that observations were essential, even if they were very valuable in answering the other questions, too.

This change of the research question into an interest in contextual factors prompted me to get outside one single university to get some comparable material. I knew that Chalmers University of Technology had received a similar grant, not to create a new engineering programme, but to reform their existing one. The project leader at Chalmers was positive to my suggestion of interviewing people engaged in the reform work.

The role of Chalmers came both to substantiate the data from LiTH and illuminate other possible developments. My interview questions in the second round of interviews were to a great degree designed on the basis of what I had seen in the LiTH team and they were practically the same at Chalmers. The idea was not to find out what the reform process at Chalmers had been like in itself, but where the similarities and differences were compared with the LiTH process. Analysing the interviews, even if crafted exactly the same way, involved two different interpretative processes. The interviews at LiTH were compared with what I had seen happening in the team meetings. However, at Chalmers I had no observational data about what had actually been going on in the team, and so the interviews were related to the analysis results from LiTH. Doing the study the other way round – grounding it on Chalmers and using LiTH as comparison and contrast – would probably have changed the thematic organisation of the study and the emphasis put on the different aspects described.

Even a third university, Luleå University of Technology, has a role in my study, even if it does not appear in this report. About the same time as I contacted Chalmers I also learnt that Luleå had started a reform of its computer engineering education. Actually, I have made parallel rounds of interviews at three universities and analysed the data the same way, even if fewer people were interviewed in Luleå. In the working papers and other papers I have presented about my study, Luleå University of Technology is described as one more example of a gender reform process in an engineering education institution. However, when the time came to write down this story, I chose not to include Luleå.

The process in Luleå and its conditions were quite different from those at LiTH and Chalmers. To make an analysis on the same level as LiTH and Chalmers would have required more data - partly because there was less data from Luleå, and partly because data from LiTH and Chalmers could to some extent strengthen each other, while the data from Luleå, because of the different characteristics of the project, had to stand on their own to a higher degree. Besides, including Luleå in the study would have required a lot of description - which, given the restricted space, would have meant giving more superficial descriptions of all the processes. Thus, I chose to report what happened at LiTH and Chalmers. Those processes can be expected to be more typical of what can be expected of gender reforms in traditional universities of technology. However, great deal of what I report of these processes was made visible to me when I compared them to the process at Luleå. So, in this report, the role of Luleå has been the anomaly which has opened my eyes to the "normal" and helped me to see characteristics which otherwise would have been unnoticed.

Observations

There was a main planning group which started out with some 12 members in the beginning of 1994, and comprised about 20 by the time I finished my data collection. Apart from lecturers from different departments, it consisted of two representatives of industry and a student representative. There were also smaller working groups, the most important being the one for curriculum planning, and others for admittance, public relations, gender issues and premises. I observed practically all meetings of the main group, most of the meetings of the curriculum planning group and quite a few of the meetings of the other groups, at least during the first 15 months. The planning period stretched from February 1994 to August 1995, when the first students arrived. In the late spring of 1995 my plans to observe the planning process became more difficult to realise, as much of the practical planning of the final period happened in more informal constellations. I did not, either, make any great efforts to keep track of all the planning groups, as I felt I had the data I needed to answer my questions, especially as I was analysing the second round of interviews at the same time and knew that they contained a wealth of information. After the first students had started on the programme and the pure planning period was over I gradually diminished my involvement. I still observed the meetings of the main group, but did not make any efforts to follow the other groups. I also stopped tape-recording.

I stayed strictly non-participant. I sat at the same table as the rest of the group, with the microphone on the table and took notes most of the time. For me it felt awkward at times, but the group members did not seem to expect anything else of me. This is understandable against the background that many of the group members themselves had been educated in a positivist research paradigm where the researcher is detached from her objects of research. As new members appeared in the group I introduced myself briefly as a graduate student from education, researching on curriculum construction. The tape recorder was not mentioned on those occasions. On a few occasions the group members referred to the tape recorder when making a statement, usually one with a reference to the internal (power) relations of the institution. As far as I can judge they were not affected by it regarding their mentioning gender issues. In the second round of interviews I asked them about the tape recorder. I did not get any elaborate answers, but the core content was that they were used to it and did not care.

I participated in the normal small talk before and after the meetings, where sometimes my research work was joked about (mainly the amount of tapes I was getting), but apart from those occasions I did not socialise with the group members. I had access to all documents circulating in the group, even to the one that was not to be given to outsiders. The project leader also arranged an access for me to a special hearing that the governing board of the university had with the group.

Apart from tape recording the meetings, I also took notes – writing down as much of the dialogue as I could - and wrote reflections after every meeting. In analysing the meetings my notes are the primary source, and when needed I have listened to corresponding excerpts from the tapes.

When analysing the meetings, I went through the notes and extracted all where gender was mentioned. The same was done with the documents distributed in the meetings. These excerpts were sorted according to their basic content, without any pattern decided in advance. Some content areas were shown to be central, recurring several times in different meetings Description of these content areas[18] resulted in a working paper, parts of which form a basis for some of the results presented in chapters 10 and 11.

I am well aware that I only made a small extract of my rich data by first relying on my notes and then further concentrating on those minutes where gender was discussed in some way or another. Listening through the tapes would probably have opened my ears to some nuances which never found their way to my notes – but I doubted that listening through my 80 hours of tapes would give me so many new ideas as to make it worth the effort, as my notes were quite comprehensive.

My concentration on those parts where gender was mentioned, instead of analysing more of the group interaction, is a more relevant objection. My primary interest concerned how and why gender issues were or were not reflected in the curriculum of the new programme. By concentrating on the parts where gender was discussed I could study how and why they were reflected in the curriculum - and to some extent why they were not (by seeing where gender discussions came to an end), and the interviews gave me more clues to why they were not discussed. The interactional patterns in the team, the team members' way of doing gender among themselves, were interesting in connection with the questions about gender in the curriculum, and I expected to be able to see enough of them for that purpose, when analysing the gender-related parts.

After the interview analyses at both LiTH and Chalmers were made and the basic outline of my findings was reasonably clear, I scanned through the observation notes once more to relate them to the areas which had arisen on the basis of the interviews. Some of these had not appeared in discussions about gender, but were discernible in the general discussions.[19] Thus, in this second phase, the observations were not analysed without any presuppositions, but rather used to highlight points which I already had assumptions about on the basis of my main data. On some points, but quite few, this led me to modify my original assumptions.

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[18] Lack of knowledge on gender issues, the ambivalence towards the task of recruiting women and, to some extent, the token position of the women were the three main areas described in this paper.

[19] Such areas were, for example, observations of the *doxa* of engineering education, contacts with the institutional environment, especially questions of status,

Interviews[20]

The first interviews in Linköping were made in April-May 1994 (three of them were made in September, with members who were new to the team). They were semi-structured and focused on the impressions and opinions of the interviewees on girls/women and computers and technical education, with a couple of questions about gender issues in general. They were analysed during the autumn of 1994.

The reformers at Chalmers were tied to the study in March 1995, and interviewed about the same issues as the reformers in Linköping at that time. The interviewees were chosen by people working close to the project leader. I asked for a "core group" of 10 - 15 persons, with both teachers and student representatives, if there were any. Obviously, they were picked up among several people who were involved in the project. I spent a week at Chalmers in March 1995 making, besides the interviews, field notes about the environment. In Linköping the interviews were also made in March.

The interviews were, again, semi-structured and focused this time on the planning process itself and the way gender aspects were given attention. The institutional context and the in-group context were also discussed.

The third round of interviews was made at both universities in May 1996, when the first students would soon be finishing their first year. This time I wanted to interview people who had been teaching or counselling those students, and the project leaders. This resulted in somewhat fewer interviews and about 1/3 of the interviewees being new to my project. The questions focused on the teachers' experiences and impressions of the students, especially the female ones.

The interviews varied in length from 30 minutes to more than 90 minutes.

As to analysing the interviews I was initially inspired by grounded theory (Strauss & Corbin, 1990). To start with, the inter-

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and conceptions of the new students.

[20] See Appendix 1 for the number of persons interviewed on every round of interviews and Appendix 2 for the interview guides.

views were transcribed (by another person) and sorted according to the university they were made in. Reading through the interviews, I marked the parts where gender was discussed or mentioned and even listened through them, correcting the transcript when needed. As the interviews were not focused, they contained much that was not of direct relevance to my research questions, and that is why a concentration on data relating to my research question was needed. This was the only time the interview itself was seen as a whole, a separate entity. I then chopped up the interviews and sorted them according to the main questions which were approximately the same in each of the interviews.

The analysis process is explicated in Appendix 3. In short, the gender-related parts of the interviews were scrutinised in arbitrary sections of about seven lines. These sections were coded, not with concepts as in grounded theory, but once with a descriptive statement of a few words, and once by underlining the central phrase in the interview excerpt itself. The statements were compared with each other and aggregated into different themes when possible. Those statements which did not fit into any "theme group" were disregarded, at least for the moment, as my purpose was not to examine all kinds of opinions there could be about the issue, but rather those which seemed to be held by at least some of the group members and thus could be expected in one way or another to influence the planning process. The theme groups were compared with each other, connections were elaborated on and on the basis of the picture which by and by emerged, working papers were written, one for each university. The themes were even compared across universities, to find similarities and differences. As a result of this, any single statement in a working paper could be traced down to the interview excerpts of which there were at least some, uttered by different persons.

This way of working with the interviews implies that the group members were not seen as individuals. I was not interested in them as persons, but rather interviewed them to gather thoughts, opinions, perceptions and attitudes which could be expected to be "in the air" in the project meetings. I did not expect an idea represented by a single person to affect the work considerably (if it had affected the work, it could be expected to turn up in the other interviews as well), and that is why they were not taken into account in my descriptions.

Of course, it would also have been possible to regard the individual interviews and connect them to the interviewees, their position, agency, behavioural patterns, reputation, gender, and age.

However, to try to sketch the kind of results I present in this study on the basis of that kind of analysis would have complicated the picture substantially. It could have answered the first part of my research questions - what perceptions the reformers held of women and gender issues in general - more profoundly. But the wealth of information about the individual reformers would, as it seems, have made the second part, about the reform processes themselves, detailed enough to make them almost incomprehensible. One single interview, not to talk about 59, gives possibilities for several interpretations. As my research question actually concerns a group process in a certain context, I have chosen to interpret the interviews simply as expressing ideas which lie at the bottom of this process.

To further play down the importance of individual interviewees, they are referred to by an arbitrary code of four digits when they are cited. Their sex is not notified specifically, but the first digit for women is 0 and for men 1. L refers to LiTH and C to Chalmers.

Other data sources

In addition to the documents circulated in the planning group at LiTH, I naturally collected and studied documents, brochures and newspaper clippings concerning the new study programmes even if I never made any systematic analysis of these.

A questionnaire was sent to all the students in these programmes plus a "control group" of new students in ordinary computer engineering in Linköping during their first week of study. (And answered by about 85-90% of them.) Their motives for applying for the programme, their educational background and computer experience was asked for, as well as some opinions pertaining to female students in computer engineering. I do not directly use the data from these questionnaires, but it has naturally affected my image of what kind of students the planning and reforming of these programmes eventually attracted. Apart from this questionnaire, no student data were analysed. Chapter 13, about the first year of the programmes in operation is grounded on interviews with the teachers, as it was the impact on faculty level of an allegedly gender inclusive programme which was my research question. My question has not been what female students are like and how they perceive their education, but what their teachers believe they are like, and what their teachers' ambitions are, as to their education.

Methodological reflections

On interviewing engineering faculty

Among all the books and articles about qualitative interviewing, a short article by Jennifer Platt (1981), where she accounts for her experiences in interviewing academic staff, was most to the point in my situation. It explained to me something about why some of the good advice in handbooks did not work for me. My situation was not quite similar to Platt's who interviewed people at her own department. But just like her, I was interviewing people who could be expected to have their own ideas of research and a sizeable number of whom were above me in rank, and just like her I was depending on their co-operation and goodwill. We both had interview questions which could be experienced as touchy - even if mine invited rhetorical answers to a higher degree. In addition, we both interacted with our interviewees outside the research situation. A situation like this brings to the fore some considerations which are not quite as relevant in all interviewing. In general, as even Platt found out, the issues of power and influence, and consequently the role the researcher adopts, are different in interviewing other academics than in many other qualitative research studies.

Spradley (1979) asserts that feeling themselves important as expert witnesses will make the research subjects enthusiastic. Most of my interviewees had so many experiences of being experts that I did not believe I could expect this to be highly motivating, but rather had to create or let some other sources of enthusiasm emerge. The interviewees' general commitment to research which could be expected to cause a felt obligation to help a graduate student with her thesis could be used as one.

One difficulty in interviewing "one's peers" is what Platt (1981) calls the need to keep one's face in the kind of personal and power relationship which emerges in this kind of relationship.

> This includes efforts to appear to get the point quickly...to treat the interview situation as one no different from other conversations and so contribute one's own quota of gossip and comment to the discussion. (Platt, 1981, p.78)

This means also offering lengthy questions and responses to the interviewee's answers and not probing into questions which the interviewee seems to be reluctant to answer. Some of my interviews were very conversational, and it also happened that I dropped a question earlier than I actually wished.

Platt (1981) goes on to point out that a shared understanding between the interviewer and the interviewee can mean failing to question common terms - the interviewer assumes that she knows what the interviewee means by the term. Because a common understanding is assumed, the interviewer is reluctant to break the ordinary laws of conversation and start asking "stupid" questions about something that is implicitly understood. This is one instance where mastering conversational skills, advocated by Kvale (1996) as an interviewer quality, gets in the way of conducting deep and well structured interviews, and where the right balance can be difficult to strike. Violating the laws of conversation by imploring common assumptions the conversation was founded on might have resulted in new insights - or it might have served to close up the interviewee's free talk and thus deprive me of interesting data.

For the same reason I practically never confronted the interviewees with the inconsistencies of their statements in the interview compared to their statements in the planning team. I was concerned that they in that case would start to choose their words better and fall back to the official rhetoric. Because this would have decreased the value of the interview for me, I chose to let the contradictions pass without verifying them and thus not getting explanations from the interviewees themselves as to why they were contradicting themselves.

Kvale (1996) warns about long interviews - a warning that I had not heeded. In some interviews there was quite a lot of talk about other issues than gender related to the reform work. I was afraid that keeping strictly to gender, would make the interview too focused. In some interviews I related narratives and experiences on gender issues, which a certain answer made me to associate to. Normally, this concluded the topic, and I moved on to other questions. The function of these conversational parts for me as an interviewer was not only to keep the conversation going, but also to make it easier and more natural to talk about gender.

All this meant that my interviews became longer than they would have needed to be, which I handled in the analysis phase by disregarding those sections of the interview where gender was not discussed.

Platt (1981) analyses the ethical dilemma I found myself in when using these conversations to evaluate the planning process from a perspective not adopted by the interviewees. Platt defines interviewees as either respondents, providing raw data as an anonymous member of the group, or informants, providing unique information to be taken at face value. I used questions which, especially during my second round of interviews, were more directed to revealing inconsistencies than I made pretence of, and to get answers to these I did what Platt calls making a respondent feel like an informant, and which posed a dilemma to her, too.

> It would have been socially uncomfortable to reveal that I proposed to judge my colleagues, and expected to catch some of them out in wrong answers. Such interviewing tricks imply not only that one is attempting to control the situation without the knowledge of the other person, but also that he cannot be trusted to speak the truth without being trapped into it. (Platt, 1981, p. 81)

I certainly used this kind of questions, especially at Chalmers, where the answers were actually used for facts - but also for evaluation. A question about the history of the reform this far could be used both to learn what had happened, but also to learn about the interviewees' ideas of the reform, which was not quite obvious from my way of posing questions.

Once my initial hypotheses had started building up I even found myself in another dilemma, described by Platt (1981).

> It seems offensive not to give some honest and reasonably full account of the rationale and purpose of one's study. It can be exceedingly embarrassing evidently to have hypotheses that reflect unfavourably on one's respondents. (Platt, 1981, p. 80)

I, too, had difficulties in telling my interviewees what my research was all about, or what I had found that far. I felt I could not state openly what I saw as the lack of gender issues in the planning process, without causing the interviewee to adopt a defensive attitude. I usually tried to give a general answer and talk about looking at gender issues in general, and when more specific explanations were asked for, I stressed the role of the context in the process.

My way to grounded theory and back again

This study has been inspired by grounded theory (Glaser & Strauss, 1967; Strauss & Corbin, 1990; Glaser, 1978, 1992). It carries the attributes of theoretical sampling and constant comparison and categorisation till the results emerge. However, it is far from orthodox grounded theory. The reason is that along the way I never felt wholly comfortable with the method, and towards the end of the study more or less abandoned it.

The start of the study followed the pattern recommended by grounded theory. I acquainted myself with a milieu, had an imprecise research question that had to do with the meaning of something for my research subjects (about the image of female students among engineering educators), and acquired a theoretical sample of a certain planning team. Later, also in accordance with grounded theory, I modified my research question on the basis of what I had found out, modified my subsequent interview questions and even my sample of research subjects, including two other universities.

As to analysing the data, I made a meticulous scrutiny of the interviews, coded them in meaningful utterances, compared these to each other – and found interesting patterns. Actually, I deviated from grounded theory by not inventing concepts, but descriptions of a few words, but still, grounded theory was my main source of methodological inspiration.

However, during the work several aspects made me doubt the usefulness of grounded theory in my case. My research questions, after the first interviews, considered more the institutional environment, while grounded theory concentrates on the actors in the environment (Alvesson & Sköldberg, 1994; Layder, 1993). The grounded theory method is supposed to bring about a theory about how individuals act and react in certain circumstances, but that was not my focus, and I never emerged with a theory.

In addition, as my research proceeded there were methodological questions which I found that grounded theory dealt with unsatisfactorily, most importantly the role of the researcher. While Glaser (1992) sees the researcher as an objective instrument, who only perceives what the data are saying, Strauss & Corbin (1990) give the researcher very much freedom to associate to the data and develop any insights which might emerge. Both these approaches seemed inadequate by the time I had understood that I, as a person, influenced the research process in different ways, and that I should both accept it and keep myself accountable for it. While I had been attracted by the post-positivist "orderliness" of grounded theory, I now saw this orderliness as containing a risk of an unreflective escape from the complexity of life and research.

By that time my interviews were both made and analysed. I had seen the data talk to me, just as I had expected and as it is promised by Glaser (1992), in particular. But I had not developed a grounded theory, nor could I expect to find one. However, what I had found seemed to fit into the framework of some existing theories. I had got acquainted with during the process. In the reading parallel to the empirical study (which is not directly encouraged by grounded theory) I had become acquainted with, first, Hirdman and, later, Bourdieu. So I found my way back from grounded theory to grand theory – however, not to testing the theories of others with my data, but to positioning my interpretations around them. For me as a new and fresh graduate student grounded theory had given solid advice on the craftsmanship of research - but it also lead me to paths where it proved itself inadequate.

Criteria of qualitative research and my study

But on what grounds could my, basically home-crafted, method be called research? Eisner (1991) enumerates six characteristics of qualitative research which can be related to my study:

1) Field focused. I have grounded my data in my observations and interviews and try to show this in my presentation. While direct conclusions are mostly drawn from interview data, the observations generally provide a background knowledge to which I compare the interview utterances.

2) Using the self as an instrument. Interpretive research always tells a story of the researcher, too, as Steier (1991) points out. My way of conducting interviews has defined much of my basic data. My experiences and the feminist perspective I had taken has to a certain degree defined what I found out from them in the analysing phase. As both my experiences of engineering education and my theoretical perspectives developed during the years of the research, new insights emerged even from the old interviews. As also Scott (1985) found out, being an academic and researching on academics perhaps even more than many other research projects leads to the everyday experiences of the researcher affecting the study.

The effects of the self being gendered are discussed in several feminist studies. I tend to agree with, for example, Davies (1985) and Scott (1985) in that a female researcher might be easier to disregard or be held in low esteem and therefore more easily observe situations and get responses where the keeping up of the official facade is less important and the answers therefore more honest.

3) Interpretive character. I have tried to interpret the meaning the actors put into institutional contexts and the idea of female students, rather than to find out how these contexts really would affect the female students-to-be or whether the characteristics of female students actually corresponded to the conceptions of them among the teachers. I have tried to interpret, from my feminist perspective, by

analysing the interviews and my observations, the subjects' interpretation of their situation. I think I have found interpretations which are not always obvious to the subjects themselves, but yet affect their behaviour. Even if these have emerged from what the subjects have said and done, they may still, more than anything else in the study, reflect my perspectives.

4) The use of expressive language and the presence of voice in text. This has been my ambition - presenting both my voice and the voice of the subjects.

5) Attention to particulars. If this is given a meaning of actually attending to all kinds of particular interactional situations, I could have done better in my observations. Even in the interviews I quite early discarded utterances which seemed to reflect opinions held by only one or two people in the group. Making some data reduction is naturally unavoidable - the multi-faceted reality can never be put in a book in its totality - but it is possible that I reduced the data more than necessary.

6) Coherence, insight and instrumental utility - which are used as validity criteria by Eisner. While my study reveals insights which I have not found in the previous literature on the disciplinary areas concerned, and which, I hope, could be of use in transforming engineering education from a gender perspective, the picture they form is not quite as coherent as I would want it to be. A unifying factor explaining all my results may exist or it may not - in any case this study did not reach it. Larsson (1993) uses the term "foundation" instead of core category:

> It is the idea that there is an exact explication of something, that a sizeable part of the data lies on exactly the same foundation. If this foundation is explicitly stated, a description is put forward of some characteristic of the data in an exact way; the interpretation is terse. (Larsson, 1993, p. 11)

This suited me better as the "foundation" on which my data seemed to lie, the masculinity of computer engineering and the need to keep it so, was rather theoretically derived than found in the data.

The imaginative techniques which Strauss & Corbin (1990) advocated were replaced by deconstructing, "examining what it says, what it does not say, and what it might have said" (Martin, cited in Reinharz, 1992, p. 149). This is done from the researcher's adopted perspective. While imaginative techniques, according to Strauss & Corbin might lead anywhere, analysing from a certain perspective gave certain focuses even to what was not in my data but could have been there.

Eisner states three validity criteria: structural corroboration, consensual validation and referential adequacy. Structural corroboration relates to triangulation, and to different parts of the data confirming each other, so that the characteristics which the study builds the interpretation on seem to be typical of the situation. In my study the interviews initially functioned as an explanation to my observations. Later, I based my analyses on statements which had recurred in several interviews. Consensual validation, by "competent others", was sought after more sporadically - not least because of the difficulty of finding competent others during the process, as research into gender and engineering education is not very well developed in Sweden. The instances I sought this, for example presenting conference papers, were valuable as correctives in some aspects, but did not lead me to question the basic ideas emerging in my analyses. Referential adequacy is related to the validity criteria above. It refers to the capability of the text to persuade the reader by the congruence of the subject matter and the interpretations both with each other and with the referential frame of the reader.

Dilemmas in reporting

While Eisner (1991) helped me to see and define my study as research, after I had abandoned grounded theory, Steier (1991) helped me in my dilemma of being a educational researcher doing research on engineers. Engineers form another academic group, and during my research, at the same time as I was learning more and more of the fine grain of engineering culture, I also became aware of the cultural differences between these two academic groups. I learnt that engineers appreciated different kinds of texts than my colleagues at the Department of Education. I foresaw difficulties in making interpretations which would be accepted by both educational researchers and engineers and felt insecure about those interpretations which I expected would be doubted by engineers. My situation could be described as journeying between two academic communities with obligations to both. While not solving my problems, Steier's words defined my situation.

> *...our conversation with our reciprocators and our conversation with our colleagues are simply different conversations, or in Wittgenstein's terms, different language games.* (Steier, 1991, p. 176)

Steier (1991) thus explains that a researcher is always participating in two conversations: those with her reciprocators (as Steier calls the research subjects) and those with her colleagues. The researcher is a translator between them, with an awareness that an exact translation is never possible. The perspectives and categories imbedded in the terminology and language of the research community can never perfectly fit the reality of the reciprocators, but always give a somewhat distorted picture. At the same time they have to be used to make the research results intelligible to the research community. The researcher is entitled and even obliged to do this, at the same time as she has to acknowledge that there is another, and quite as legitimate, discourse going on among the reciprocators - one in which she is also involved, even if she is not able to take part in it as a full member because of her disciplinary perspective. This was quite an accurate description of my situation where I felt I had an increasing understanding of engineering culture, at the same time as I felt quite foreign to it and felt I was analysing it from perspectives and by means which would not be understood by my "reciprocators".

The question of writing the story also became problematic. The ordinary textbooks in reporting a qualitative study maintain the importance for the reader of really getting access to the sphere the researcher has been working with. To succeed in this there must be an adequate description of the phenomenon, even if this means balancing it against the requirements of structure (Larsson, 1993). According to Larsson the style of the writing is part of the research results - the aim of the research is to interpret the researched aspect of reality so as to make it intelligible to others, to grip their comprehension and direct it on a new course.

Again, Eisner (1991) came to my aid in his way of stressing the artistic process in writing. His expression of "the management of news" was more helpful than the summons of other ethnographic writers to thick description. Even Eisner stresses the importance of thick description, but his model of using themes derived from the data as hubs around which to group the "thick" stories relating to the theme and then summarising it all helped me to structure my writing. Instead of a core category emerging from a myriad of other conceptual categories my report came to present some underlying problems and themes connected to the task of creating gender inclusive engineering education.

7. How gender equality in higher education became pedagogical reforms in engineeing education

This chapter is a prelude to the description of the gender reform processes at the two technical institutes. The impetus for the reforms were grants which these two universities had received from the central authorities. While the description at the two institutions reveals a number of problems in implementing gender reforms in technical education, the larger context should not be forgotten. Running into obstacles when working with gender in academia is not only a problem on the level of institutions, basic units and departments – even at the level of state authorities there are forces which work to steer efforts to change gender contracts in academia into something else.

The chapter is based on interviews with three members of the Council for the Renewal of Undergraduate Education, the archives of the Council, and an interview with the chairperson of the parliamentary committee for equality in higher education.

A chronology of the grants at central level	
Nov 92	Report of the Advisory Committee
Feb 93	Budget statement from the Ministry of Education
	Report from Parliamentary Standing Committee on Education
Sept 93	Conference where grants were presented
Oct 93	First applications for the grants
	Seven universities chosen for elaborated applications
Dec 93	Five universities chosen to receive grants
Feb 94	Contracts signed with five universities for the period of academic years 93/94 - 95/96
Aug 95	The programmes start
Sept 95 - May 96	Evaluation, initiated by the Council and conducted by an educational scientist

Interactions on the central level

In 1992 the Conservative minister of education set up an advisory committee which was to probe into gender inequalities in the academic world. The task of forming and leading the committee was given to a female member of parliament from the liberal party, who assembled a group which consisted of academic teachers, high-level academic administrators and representatives from the Ministry of Education, all with an interest in gender issues. The area which the work was to cover was wide, comprising both career hierarchies, the Swedish university matriculation examination, programmes with sex imbalance in student numbers, curricular issues - anything that had to do with gender in academia. The committee issued its first report the same year.

This small report contained a whole set of problems definitions and measures to be taken on the different areas which the committee had looked into. Among other measures the committee regarded it as urgent

> that the direction and content of the education be scrutinised... so that the female perspective on science ,and equality issues are brought to the fore in the education and that course literature etc. be supplemented with these aspects in mind.(Ds 1992:119, p.8, Nov 92)

The considerations were to comprise all university education. The most concrete suggestion in the report was

> that an amount of approximately Skr 20 million be allocated to the Council for the Renewal of Undergraduate Education for the next three-year period to promote equality in undergraduate education at university and to establish a special reference group within the Council (Ds 1992:119, p.8, Nov 92)

The Council for the Renewal of Undergraduate Education (in this study it is simply called the Council) was a funding agency established also in 1992 to administer grants from the state for pedagogical reform projects of different kinds. Most often these were small projects and the Council could finance an application from an individual teacher for an innovation he och she wanted to try. There was one programme area, that of integrating environmental aspects into undergraduate education, where the Council had a firmer hold of a whole area. In practice a reference group created for this programme played a significant role. Gender was not a high priority area in the Council; the previous year 7% of the project grants had been allocated to gender-related projects.

Twenty million Swedish crowns (or fifteen, which was the eventual sum) is a sizeable amount of money in the Swedish context, and even in the context of the Council - the fifteen million crowns would make up 25-30% of all project financing by the Council[21]. But the advisory committee was confident that there really was interest in the issue in the Department of Education – if not otherwise, at least because there was some political pressure for it.

The original idea of the committee had been that there would be a large gender programme, modelled according to the environmental programme in the Council. Just as the environmental programme was integrating environmental aspects in undergraduate education, the gender programme would integrate gender aspects. But it soon became obvious that the Council - the chairman and the secretary who were contacted - was not at all interested in administering this money. Actually, they had to be pushed. For their part the two men could not see an analogy between gender and environment. They saw environment as a knowledge area, and integrating environmental aspects meant integrating new knowledge. In contrast they saw gender as an area where there were differing, competing opinions - nothing substantial and indisputable to implement. Besides, they tried to point out that they, as men, were hardly suitable for carrying out the task.

But when pushed enough, they thought it over. If they should be given the task anyway, how could it be handled? What was the Council's first-hand knowledge of gender? There were three gender projects at that time financed by the Council: one in mathematics, one in engineering and one in journalism. A specific gender problem could be agreed on: the imbalance in numbers of men and women in programmes of mathematics, science and technology. This problem could be seen in pure statistics.

About this time the secretary contacted a female member of the Council, one with an engineering background herself, and presented her with the offering from the advisory committee. While the secretary was still reluctant to accept the offering, the female member became enthusiastic. From then on she was the one who took the most interest in the issue.

> /The secretary of the council/ called me after he had met /the chairperson of the advisory committee/ in a confused state and told me about this in somewhat ridiculing terms. He didn't think we should get involved, but I was really enthusiastic and ex-

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[21] In the fiscal report (found in the Council for the Renewal of Undergraduate Education, 1995) for 1993/94 these projects make up 17% of the total expenditure of the Council, in the budget for 1994/95 19%. "Project financing" as I use it here comprises the posts "Projects", "Environmental Studies" and "Equality between Sexes" as stated in the Annual Report.

> pounded at length to him about why I thought that the Council should get involved in this. It was about technology and science and that the Council should support projects. **But in the advisory group's little green book it actually says nothing about technology.** All right, but since I became so enthusiastic so quickly, there must have been some mention of it in my conversation with /the secretary/, it was in tune with what I have been working for the whole time. It was natural that I then took so much responsibility for this in the Council. (MC[22])

So, the answer of the Council to the advisory committee was that they were prepared to take on the task, if they were allowed to do it their way. Consequently, the Minister of Education in his budget statement stressed the need of recruiting women into science and technology. And so, for the following year's budget he targeted the money for the recruitment of women into science and technology.

The Parliamentary Standing Committee on Education, when having read both the report of the advisory committee and the budget statement were still concerned about undergraduate education in its entirety in their report and expected the money allocated to the Council to be used in the general efforts to realise gender equality.

> The Committee on its part wish to emphasise how important it is that stipulation of the new Higher Education Act , that equality between women and men shall always be considered in activities within the universities and colleges, results in concrete measures...The Committee expects that deciding bodies at all levels, as well as teachers and other employees within higher education, actively seek ways to realise this fundamental principle expressed in the Higher Education Act. The resources that will be made available to the for Renewal in Higher Education, according to the government's proposal should support and stimulate these efforts. (1992/93:UbU14)

However, the money was allocated to the Council, and its position as subordinate to the Ministry of Education enabled the money to be used according to its own intentions, which the Minister of Education had formulated. The objection of the Parliamentary Standing Committee on Education was left without notice.

So the central authorities managed to reformulate the political document of general gender equality in academia into one which they felt was easier to handle, the relatively well-defined problem of recruitment of women into science and technology. Defining gender equality as "more women into technology" is well in accordance with the Swedish gender equality discourse, which to a great extent is based on liberal feminism and where equality quite often is measured in numbers. In Lundgren's (1983) terms the formulation of the grants as aimed for recruiting women into engineering is an example of the interplay between the vertical and horizontal reproductive spheres. The need to produce an increased number of engineers made the vertical sphere put some pressure on the horizontal sphere of engineering education institutions. As there is a shortage of young men, young women have to be targeted.

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[22] MC = (the female) member of the National Council interviewed

This is also a popular interpretation in a situation where the technological and scientific undergraduate education has been extended to the extent that the number of secondary school graduates with an adequate background is expected hardly to be able to fill all the places. Women are not only desirable in technical and scientific education; it is essential that they do not choose traditionally female study areas, but help to fill the void. The issue, as the minister of education put it, is about the future of the nation:

> Apart from the self-evident aspects of justice, /the minister for education/ views the ambition to increase equality between men and women in higher education as a part of the general effort to strengthen Sweden as a nation built on knowledge. It is important to be able to recruit women to the longer academic programmes within technology and science, as otherwise there will be a lack of students in these programmes. (1992/93:UbU14)

But from a feminist point of view the situation can also be interpreted as transforming the money destined to introduce gender perspectives into undergraduate education and thus promoting the understandings and, hopefully, consequent changes in mental and behavioural patterns of both female and male students and teachers in general. After the transformation the money was to strengthen a male-dominated area of education and those women who were interested in trodding that male-dominated area. What became of the money was one more "culture to the masses" project, as Bourdieu calls the projects which aim to give some members of the dominated classes access to part of the culture of the dominant classes.

Gender equality is seen as something inherently and unquestionably good in the Swedish discourse. It can thus be used to legitimise or reinforce other interests. It is all the easier because gender equality is a fluid concept which can be defined, and is defined, in many different ways in the Swedish discourse, depending on the context. The measures for reaching gender equality can be seen as varying accordingly. In the report of the advisory committee several definitions are implicitly in use. Some of them refer to the equal value of women and men and others to equal opportunities. The enlightenment project originally presented by the advisory committee - introducing gender aspects to all undergraduate education - can be interpreted as an example of the former: making women and their experiences visible and as valued as men among both female and male students. The project finally launched was rather an example of an equal opportunities approach - giving women an opportunity to go into the presently valued masculine fields of science and technology.

So "higher education" became "education in technology and science" and "gender equality" became "recruitment". And "pedagogical reform" was introduced by the Council as the solution to the problem.

Transporting the money to the local level

Two leading principles were agreed on: the money should not be used for recruitment projects, but for pedagogical renewal[23], and the projects financed should make thorough changes to the programmes. The earlier approach of trying to enhance recruitment by information was to be abandoned. The new basic idea was not making the female students a problem, not seeing the problem as one of information, but of education. This was a very radical idea, indeed, even if it was natural for the body which was to distribute the grants.

All the rectors of higher education institutions providing scientific and technical education were invited to a seminar where the problem area was discussed and the possibility of applying project grants was presented. Rather than spreading out the grants to several projects all around the country, a few major projects would get sizeable amounts of money. From now on gender in engineering education was not only defined as an recruitment issue, it was also increasingly subordinated to the issue of reforming the pedagogy of the education. The invitation read:

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[23] The aspect of informing the women about the new education, could, naturally, not be abandoned altogether, so a portion of the money would still need to go into that kind of campaigns, but what was acceptable in this aspect was discussed in the Council.

> The Council for the Renewal of Undergraduate Education *announces a national competition for funds* to institutions of higher education that present project plans that demonstrate a sincere will to reform in accordance with the intentions and guidelines as laid out in the proposition and its preliminary work ... According to the Council it is important to apply existing knowledge of what needs to be changed in order to improve the learning climate for students, and not least for female students. (Dnr 86-478-92/93, June 93)

Thus, all students were to benefit from the reform, even if female students were to be considered in particular. The necessity of recruiting women to tap the reserve was highlighted during the seminar. The programme of the seminar focused on the gender question from this perspective. The final announcement about the grants also stated that recruiting women was the ultimate aim.

However, both in the seminar and in the final declaration there was a message which was interpreted as quite as important as gender. "Enligt rådets mening bör därvid övervägas om det inte vore lämpligt att utgå ifrån en mer problemorienterad inlärningsform än vad som i dag är vanligt." (Announcement from the Council, Dnr 46-62-93/94, Sept 93)

Practically all the universities invited sent in an application - and practically all of them contained an element of projects or problem-based learning. In the interviews the members of the Council regretted this and asserted that their idea of project- and problem-based learning was taken too seriously by the institutions.

> We managed to sell PBL too well. I had an input where I mentioned PBL and presented some international examples, and being engineers, they accepted these as the truth...I felt that there nevertheless was a belief quite simple solutions. And then I suppose they thought that since we had mentioned PBL that they had to put PBL in their applications if they were to get funding. (MC)

This expectation might have been quite correct. All the projects finally granted had a basic element of project work or problem-based learning. One of the few projects without that focus was originally regarded as interesting but discarded in the final selection.[24]

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[24] Interestingly enough, this programme in computer engineering, and in that respect comparable with those at LiTH and Chalmers, was realised without the state grant and, at least initially, managed both to recruit and to retain more female students than any of them. The reason given by the members of the Council in the interviews for not granting this project was that the changes

Now it should be the time to appoint the reference group advocated by the report of the advisory committee, and mentioned both by the Parliamentary Standing Committee on Education and even by the minister of education when referring to the report. However, a reference group was never appointed.

> The difference between environment and equality is that it didn't take us long to acquire a knowledge base on environmental issues, but when it come to equality it's doubtful whether there is any knowledge at all. And those who claimed to represent this so-called knowledge were divided in different camps...you can't form any reference groups in the area of equality... **Do you mean it's difficult to get a reference group that is agreed?** I think it would be impossible. It also says in /the report from the advisory committee/ that /the committee/ would willingly provide names for a reference group, but I don't see how such a group would benefit us at all ... One of my first proposals, which the council accepted was that we would not appoint any sub-committee. And there were two reasons for that. First there is a risk that we would only get one group of those fussy biddies. And, secondly, it could be interpreted that the Council is not interested in equality. So all decisions were to be taken at the meetings led by the proper chairperson. (Secretary of the Council)

The original idea of taking in gender experts in council meetings when needed was not practised.

The decision of the Council not to appoint a reference group mirrors a common conception of gender issues in the Swedish academic milieu: that women's studies are normative and not objective, and, thus, there is no impartial expertise as there is, for example, in environmental issues. Not appointing a reference group meant that the projects were chosen and surveyed without support from people familiar with the research areas of gender and technology or gender and education.

It was the Council itself which chose the projects which received the grants. Originally, seven were chosen to send in an elaborated application, and of them five were chosen to get a grant.[25]

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were not profound enough.

[25] It is unclear to which extent the Council influenced the projects in this phase. The female member interviewed reports that they were "quite steering" in helping the institutions to formulate their final applications, while this is not verified in the other sources.

> **What were your criteria?** - - - It's hard to give a simple answer to that. If they followed our guidelines, to really start from scratch. And trust in the project leader was also a significant factor. Not to mention intuition. When we read the applications, /LiTH's/ was more solid, you went back over it and it seemed more well planned. And it was the same for Chalmers. (Secretary of the Council)

It was also important for those applying to "think big". There was a lot of money to distribute and profound changes were asked for. The changes should be of such proportions that the interest of individual teachers was not enough. The authorities of their universities were involved in the application processes and had to assure support for the programmes. [26]

Of the projects, two were in computer engineering, one in science, one in mathematics and one generally for a lower-level engineering college. The allotment of these 15 million crowns was deemed to be worth a press release, under the heading "More than 15 million to the renewal of education in science and technology. New curriculum content and new organisation benefit both boys and girls!" (Dnr 46-172-93/94, Dec 93)

Here the gender issue was further unemphasized - from women being an object of particular concern in the invitation, they became a group equated with men as to the benefits of the reforms. The solution mirrors the non-conflict approach of Swedish gender politics, where the basic idea is that gender equality is good for all - both the society as a whole and the individuals of both sexes. In that context it is natural to reformulate a gender project as something which "benefits both boys and girls".

When it finally came to writing the contracts between the Council and the individual universities, gender aspects had disappeared totally. In the contracts there is no mention of gender or women, just a directive that the grant is to be used to "change the content and working methods in the education".

This background is important to bear in mind when following the work at the two institutions. Formally, there was no requirement to consider gender. Even informally there was at least as much interest in the working methods as in gender on the part of the authorities. The female member of the Council organised some seminars for all of the projects, where they could report to each other and the Council and discuss common problems, and where gender issues were sometimes presented by different people. However, not all of these focused on gender, either, and the number of people attending from the different institutions varied.

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[26] The interest of the central authorities during the course of the projects varied greatly between the institutions in spite of this.

> They took the easy way as far as content was concerned. They made such general statements as 'girls want more liberal arts' and thought that was sufficient. I think that's too simplistic. ...And the method was also too simple. And what never came up was this male culture that exists in physics and engineering education. And that's why I was a bit concerned and felt that we should organise support for them, series of seminars...Now, I must say that not everything turned out as I wanted it to because I hadn't the energy to look for those lecturers we would have needed. (MB)

Project evaluation

The interest in teaching methods rather than gender is also mirrored in the evaluation of the projects which the Council commissioned. Initially, an evaluation had not been planned. However, the female member of the Council stressed the issue, and an educational scientist with an interest in collaborative learning, but with no record of gender research, was eventually appointed to do the task.

> I think it would be important to follow these projects over a longer time. I discussed this at length with the /the secretary/ that they should be evaluated, and I've just heard that Inger Wistedt will be doing it...Inger Wistedt is an educationalist and has no pronounced gender perspective as far as I know. But I suppose it reflects/the secretary's/ reluctance to come to terms with the gender issue. (MB)

The evaluation report, consequently, discusses the gender aspects only to a minor extent. Some statistics on recruitment and attrition are presented, and it is concluded that women drop out of the programmes to a greater extent than men. However, by correcting for the background of the students in the statistical calculations, the conclusion is that this may well be due to more female students having an unconventional background.

The major part of the evaluation report gives examples of, and discusses the problem-solving strategies of groups of students in relation to project aims concerning learning and in relation to the academic context. It establishes that group work is not necessarily appreciated by women.

> We have not been able to find any data to substantiate the notion that female students in general prefer co-operative forms of work. Some of the female students who were interviewed actually denied that they had preferences for group work. (Wistedt, 1998, p. 109)

After presenting some evidence for such a conclusion in the beginning of the main body of the report, the discussion is in principle gender-neutral. The overall conclusion is that the projects have made profound efforts to change teaching and learning methods as well as the view on curriculum content, and that this work is sustained and will probably have effects even outside these programmes.

Even the chairperson of the advisory committee was satisfied at the time when the project programmes had been running for one year. Once the task had been given to the Council, the committee had let go of it. The chairperson was aware that the reformulation had originated in the Council, but also pointed out that it was the way the Parliament had decided the work was to be done, when accepting the proposition. The Council had kept her continually informed, and she found that the recruitment figures were encouraging and that the universities really had made efforts to change their education in a profound way. She fully accepted the reformulation of the mission by the council, as well as the discarding of the idea of a reference group. Lindensjö & Lundgren (1986) state that it is often more important for the central authorities to see to a decision being made than to follow it up, and that it is not uncommon that reforms which only partially follow the original intentions of the central authorities are seen as satisfactory.

What the formulation of the projects has done, in the societal context, is that the projects have managed to change the conception of the problem of underrepresentation of women in science and technology from being one of information to being a problem that has to do with the educational context. The existence of these projects is quite well known. And at least partially they can be attributed the fact that it is more widely realised today in Swedish engineering education that the recruitment of women into science and engineering is not just a question of telling them what an interesting area of human activity these fields are and what rewards await them, but that the education is inhospitable for women and has to be reformed to improve female recruitment. In the words of the secretary of the Council:

Even if an awful lot of girls dropped out, we have at least shown that this is not a question of information but a pedagogical problem, and I think that would be very beneficial. (Secretary of the Council)

8. Introduction to the empirical report

Themes of the empirical chapters

These chapters describe processes at two universities of technology. The ambition is to show how the context of a university of technology forms the results of a gender reform both directly and indirectly. More precisely, it is a description of how the gender contract of the university of technology works in both overt and covert ways. However, it is not only the gender contract which affects the process of planning gender inclusive engineering education. While gender issues are in the foreground, other undercurrents must also be taken into account.

The empirical report could be organised as an account of a group of people and their journey from A to B. It is not. The group of people carrying out the process and the context in which they are doing it, as well as the end product of the process, are described. But their doings are not followed chronologically. Instead, some aspects of their context, of the conditions they are working under, of their strategies of handling them and of the consequences of these strategies, are emphasised. The focus is not on the process, but on what it says about its origins, its actors and its context. That is why the organisation is not chronological but thematic.

The study is based on two groups of people, at two universities of technology. The two reform teams had basically different approaches: at LiTH the team was constructing a new educational programme, while the team at Chalmers was reforming an existing one. Their institutional contexts, compositions and work forms, among other things, were different. It is, above all, the differences that this study concentrates on when it compares the two teams.

Three chapters describe the planning phase of a curricular reform. Basically they intend to describe: 1) The "inner frame" - that is basic assumptions which were internalised among the reformers, 2) the group context - how the interaction patterns in the group of reformers affected the outcome, 3) the outer frame - the institutional context in which the reform was taking place and how this affected the outcome. A short chapter stating the basic ideas behind the appearance of the programmes just before the start functions as a conclusion to the first three chapters and as an introduction to the last chapter which describes the implementation of the planned reforms, with some observations which further illuminate the gendered context in which the reforms were taking place.

Chapter 9 gives a description of the reformers' conception of female students and their present and future tasks and position in computer engineering and computer engineering education.

Basic conceptions of what women are as human beings and as students can be expected to have a great, even if implicit, effect on what kind of education is planned for female students. What the reformers think of women and possible differences between women and men, especially with regard to technology and learning, is the first focus of the study. It becomes obvious that many of the reformers are puzzled by the lack of interest of women in technical education. At the same time the two sexes are conceived to be different - and in ways which might make technical education, even of a reformed kind, be less in accordance with women's preferences.

As to the position of women in engineering education a basic concept is found to be that of a *feature*. Female students are seen as an asset to the education, with new perspectives and a disciplining effect on the male students. Consequently, female students are seen to be a very positive feature in engineering education. Connected to this is an all-win conception of female recruitment.

In chapter 10 the individual reformers with their individual conceptions are brought together in a working group. The focus is on group work - how group dynamics affect the result of the reform. This chapter introduces the problematics of *competing interests* and *lack of knowledge,* factors which gear the reforms away from gender issues. A deeper examination is done of the position of the women in the planning group. Here it can be seen how the *token mechanisms* working on the male-dominated environment of a university of technology affect the work of a gender reform group, even when it in itself is gender balanced.

Chapter 10 already points out to the institutional context where the group is working. This is scrutinised in chapter 11. The concepts of *reputation* and *legitimacy* as well as *institutional support* become central. The idea of a gender reform has double connotations in the institutional context: there is a general desire to recruit more women at the same time as "feminine" is a concept which is not seen as consistent with engineering. Thus gender reforms are both welcome and legitimate and suspicious and in need of special legitimation - all depending on the situation and the subcontext. The need of the reformers to navigate in this context and the strategies they apply for doing this are examined in this chapter.

Chapter 12 bridges the gap between chapters 10 and 11 and chapter 13 by shortly accounting for the results of the planning phase, the programmes as they were viewed a few months before the start.

Chapter 13 concludes the study. It is based on data from the teachers on the reformed programmes, rather than the planners of the reforms, and follows up the reforms during the first year of the implementation phase. It introduces the concept of *academic orientation* as a contrast to biological sex as a criterion of whether a student is considered by the teachers as suited for the new programme. Chapter 13 also returns to the question of how female vs. male students are viewed. While chapter 9 takes up this question on a more abstract level, the teachers in chapter 13 base their statements on their own experiences. Teachers' considerations about the future of the programme are also touched upon in the final view of the institutional position of the programmes.

Together the five chapters try to illuminate the position of women and gender-balanced education, that is, the shape of gender contracts in the different contexts of a university of technology, and how these contracts affect a curricular gender reform. Chapter 9 refers mainly to the cultural symbolic level by examining the reformers' concepts of female students, deriving both from societal conceptions and conceptions prevalent in the engineering education context. Chapter 10 refers mainly to the daily interactions level by examining the interaction patterns in the reform group. And chapter 11 refers to the structural level by examining how the change in the prevailing contracts, which would be brought about by the new educational programme, is regarded by the rest of the organisation. Chapter 13, finally, sums up all these levels and points to the future, by examining both the teachers' concepts of female students, their daily interactions in the course of teaching, and the organisational position of the new gender-reformed programme.

A short chronological account[27]

To supplement the themes in the different chapters and to enable the reader to place them in, not only institutional, but also chronological context, short accounts of the processes at the different universities are given here. For the part of LiTH this is based on my personal observations, while the description of the process at Chalmers is based on interview accounts and some documentary material (mainly Jansson, 1995 and 1998).

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[27] In Appendix 6 some of the events recounted here are presented in a table.

LiTH

LiTH sees itself as a young and dynamic institution. It is part of a university comprising both liberal arts and medical faculties besides the technical one. However, the technical faculty seldom refer to the university, but rather talk about themselves as the Institute of Technology. The institute was founded in 1969 and has now about 6000 students.

At LiTH computer engineering is an important programme. The university was the first in Sweden to start a programme in computer engineering. LiTH still regards its programme as the best in the country and is proud of the research of the computer science department.

The leader of the computer engineering programme had for some years been a professor who, after a successful research career, had become more and more interested in pedagogical matters, first and foremost in problem- based learning utilised by the medical faculty at the same university. The invitation from the Council resulted in an application to create a new computer engineering programme, to start with a small group of thirty enrolments a year, where problem-based learning would be used all over.

The leader of the computer engineering programme became the leader of the project and the father of the new programme. The first core group of planners was basically chosen by him and comprised persons around him at the department, and others who he knew were interested in pedagogical innovation. Apart from teachers from the technical faculty, the director for social studies and communication at the computer engineering programme, a central administrator, two representatives from industry, one representative from the PR department and a student representative, chosen by the project leader, were also affiliated. A representative from a secondary school attended the meetings during one period.

The group consisted of 12-14 persons during the spring of 1994. It was relatively stable. The project leader belonged to the Department of Electrical Engineering, but many group members also came from the Department of Computer and Information science. During the autumn of 1994 the group was joined by three new members and during the winter 1994-1995 the group grew rapidly, as many people were appointed to specific tasks on the new programme, and quite a few of them chose to attend the general meetings. Up to twenty people were present at the core group meetings at that time.

The core group was divided into subgroups according to the perceived need. To start with three were formed: curriculum, recruitment and teacher education (the last one never actually functioned). Later during the spring even groups for organisation (for both organisation and economy), admissions, and premises were formed.

In September the governing board of the university asked for material to form a basis for the decision whether to allow the start of the programme or not. There had been no clear documents emerging from the process. During October the most important task was to compile this material. In the beginning of November the governing board of the university, after a thorough investigation, decided to start the programme

A new working group, for gender issues, was started in November.

A well-attended seminar was arranged with three practitioners of problem-based learning. In the spring of 1995 another seminar was arranged, about gender issues. In the spring of 1995 the team also made study tours to two other universities to learn more about projects as a teaching method in engineering education

As to special recruitment measures the representatives from the programme attended a vocational fair together with the other programmes financed by the Council. In October 1995 the student representative, who had been given a position as a project secretary, made short visits to two secondary schools to investigate the reception of the programme ideas by female pupils. In addition, in the beginning of 1995 groups of female faculty members and female representatives from industry, together with the team's student representative, visited secondary schools in the area to interest female pupils to take a closer look at the new programme.

The practical problem of premises was solved quite late in the spring. The new programme needed premises of its own, and, finally, a temporary arrangement was made by dividing a bigger classroom with screens.

In the autumn of 1996 thirty-five students started on the programme. Of these 16 were women, and 4 of these 16 had been accepted from social sciences background from secondary school, after a selection process by interviews. Of the 19 men, 1 had a social sciences background. There had been many applications for the programme. The lecturers during the first year had been partaking in the general planning work, and thus had an understanding of the basic ideas of the programme, while some of the group tutors had not followed the basic discussions. The curriculum of the first year can be found in appendix 4.

During the autumn term there was dissatisfaction both among the students and among the teachers. The students did not think that the programme followed the outlines stated in the recruitment brochures: there was not as much subject integration and non-technical courses as had been promised. Both the teachers and the students were troubled by the results of the first examinations. After the programme had been operating for six months, in the middle of the second term, the students had to move out to a building on the fringe of the campus area.

The interest in the programme was great outside the university and a succession of journalists visited the students. Inside the university the programme did not attract quite as much attention and appreciation.

Chalmers

Chalmers is an old (founded in the nineteenth century), institution with more than 8000 students. It has traditions and a solid self-image as the best in the country. Computer engineering at Chalmers has a "guaranteed" student body of young men from the area, who, after the education, normally get an appointment in the local bigger companies. Computer engineering was one of several programmes and had no special position.

Actually, the reform had started before the money came from the Council. There had been changes in the programme committee. Most importantly, a new programme director had been appointed. The national evaluation of computer engineering programmes had pointed out some problems with the programme at Chalmers, and these were taken seriously. When the money from the Council became available, the female vice-president of the institution, who was also a member of the Council, urged the new programme director to apply.

The money was allocated to the programme and the work was started with a general meeting in February 1994, where basically everybody who had some function on the programme was invited. During this meeting the basic ideas of the programme were presented by the programme manager and the vice-president. Even if there was quite a lot of discussion the ideas were generally accepted. The next meeting was held in April, for those who were interested in working with the programme themselves. There were about 40 participants, both students and faculty. In general the meeting was experienced as very inspiring, not least by the students who got to work with the faculty on an unusually equal basis. Four critical areas were defined: First-year studies, the curriculum of the whole programme, recruitment and premises. Each of them were allocated to a working group. In the autumn even a group for pedagogical development of the teachers was formed.

This was appreciated by all parties. The core group consisted of the programme manager as the project leader, the student counsellor, the pedagogical consultant of the programme, the programme secretary, a representative from computer engineering and a student who was engaged as a co-ordinator for the project. Other teachers on the programme were also engaged, especially those who usually taught during the first years of the programme. Students played an important part in the process. In December 1994 a new programme secretary was appointed with competence in psychology and an interest in gender issues.

The group for first-year studies stressed the need to introduce the student into computer technology right from the start, instead of the traditional start with mainly mathematics courses. Group work was advocated. The working group for the curriculum managed what had seemed impossible before - to cut radically the number of obligatory courses.

The recruitment group started with several innovations in the institutional context. Outreach activities like inviting secondary school girls to hands-on weekends were introduced, as was radio advertising. For the continuous enhancement of pedagogical innovation among the teachers a series of gatherings was to be started, where all the teachers on the programme would have a chance to get together and both exchange information and experiences and get some new inspiration.

The programme got a chance to take over a building which could be remodelled into a "study centre" housing group rooms and computer facilities.

Horizontally, the rest of the university did not know very much about the extensive reform that was going on. However, the positive attitude and support from above, from the central administration was very important. Towards the end of the planning phase the reformers saw other programmes which started to make similar reforms.

In the autumn of 1995 109 students, of which 17 were women enrolled on the programme. The first year's curriculum can be found in appendix 5. The new programme features were more freedom in the choice of courses, much more project work, spreading out mathematics from the first year through the education and creating a workplace for the students.

Perhaps the most important reform during the first year was introducing the project about computers in society, where the students worked in groups to look deeper into some context of computer technology. The project leaders were very satisfied with the resulting reports. And not only the project course, but even a lot more of the first year's teaching was to be done in tutoring groups, in programming, mathematics and computer engineering. Even the teachers also had more co-operation than before in trying to co-ordinate some parts of their courses.

As to the institutional context, during the first year of its operation the reformed programme became the pride of the university and an example for other programmes which needed to reform.

ui 122

9. Reformers' ideas about women and engineering

This chapter looks at some basic background ideas concerning the mission the reformers were to undertake. The individual reformers give their views on questions such as why there should be more women in computer engineering, why there are not more women in computer engineering, what is the situation of women at present in computer engineering education and in what way female students differ from males.

The chapter is mainly based on information from the LiTH reformers, as they were the ones who were interviewed more extensively about this kind of basic questions. However, these interviews are supplemented with some features in the interviews conducted at Chalmers, when they differ from those at LiTH. The sample of fifteen persons at LiTH is quite small and the interviews were not very deep. Therefore these results cannot be expected to mirror conceptions about female students at technical institutes in general. The individual variation in the answers is not given special attention in this account, either. Nevertheless, these answers to some basic questions can be expected to affect the concrete ideas about the new education, expressed in the planning process.

Why should there be more women in computer engineering

By engaging in the reform work the interviewees had professed themselves to the opinion that there should be more women in computer engineering education. Even if the general question of why more women should be recruited to computer engineering may not have a direct connection to the appearance of a computer engineering curriculum, it nevertheless mirrors a conception of the relation between women and computer technology and in that way a basic attitude to the work that is about to be undertaken.

Practically all of the reformers at LiTH expressed the desire that more women in computer engineering would influence technology positively. Women were expected to carry different values and perspectives than men, and these would be needed to create technology which would benefit both women and men in an better way. At LiTH this was the firm and often expressed opinion of the project leader, which might explain the popularity of this answer. For very few of the reformers actually had any examples of what values and perspectives they meant.

When the reformers were asked how they would expect the education at the university to change, if there really was a sizeable percentage of female students, the answers did not take up values or perspectives. Instead, when thinking of an increase in the percentage of female students at their university, most of the reformers expected a change in the social climate of the institution. They expressed concrete experiences of mixed sex groups and classes, compared with all-male ones. There female students had already made an impact, according to their experience. But only a third of the interviewees believed in changes in the education itself. Changes in curriculum content which would be brought about by more women were difficult to concretise:

> I think you need to include some female aspects from the very beginning, when the course is being planned. I don't know what difference it would make , but everyone says there would be one, so I believe it as well. (0320L)[28]

Those two who could give a more precise expectation talked about widening the content to include societal perspectives and complained about the technical narrowness of engineering curriculum. However, even for them it was a question of widening the present perspective. Introducing a new perspective which would delimit the influence of the present one was not envisioned. No negative consequences were expected from an increased percentage of female students to the present mode of functioning of the education, no conflicts between the present state and the new perspectives were envisioned.

The lack of belief in women really changing technology was also evident when the reformers talked about the students' future professional life. All believed that both women and men would find good jobs, but women were expected to go to different areas than men. They were expected to engage in administration, personnel management, man-machine interfaces, environmental areas, medical technology, and education. (Project leadership, as an activity which means working with people, and research were mentioned by one interviewee each.) In general, women were expected to want to work with people to a greater degree than men, who would be more interested than women in working with pure technology. That women in some inherent way are more suited to work with people was not expressed directly, but lay beneath some of the answers:

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[28] Each person interviewed is given a an arbitrary code of 4 digits. The first digit for women is 0, and for men 1. L denotes LiTH and C stands for Chalmers.

> ...Of course, if you look professionally at what is done in these areas, it's just as much for women as for men, so to speak. When you're out working, there's really nothing that would benefit one of them more than the other. And I think that the sector would be greatly improved by young women because a lot of the work is with customers. (1917L)

Thus, it was expected that women primarily will be going into areas which are more marginal if the mission is to change the values and perspectives of technology. Even Håpnes & Rasmussen (1990) find that female students are found in the areas defined as the margins of computer engineering - without discussing whether women choose the margins, or whether they are regarded as margins partly because women, and not the men, choose them.

In the visions of the interviewees, the female perspectives of technology will show themselves in the areas where women will be going - the "human" areas of technology, and not in the hard core of technology, which is still supposed to be populated by males. It also means that women were expected to go into areas which are less interesting for men, i.e. they will not compete with men. The implications of the vision of women as something different, being able to transform technology, appear not to be really rooted in the world view of the reformers.

Why do women stay out of engineering education

One principal problem which seems to have puzzled the reformers more than the question of what women can bring with them is the question of why women reject computer engineering. Obviously the question had also been discussed with colleagues several times. But only a few of the interviewees mentioned that they had acquired any knowledge on the issue. (Those four people who did referred to a conference, a researcher's statement, a TV-programme and some literature.) They were probably not the only ones who had been influenced by established sources of knowledge, but references to the reformer's own experiences were much more common when answering the question. And the lack of experiences of their own could be used as an explanation for not being able to answer.

> I find it difficult to find an answer to that. I am not a girl myself so I don't really know what... (1207L)

Discussing the question, after stating that they really did not know the answer, most of the reformers suggested that the reason somehow was connected to girls' special characteristics, which were most often seen as a result of their socialization at home or at school - even if some of the interviewees suspected that there might be innate differences, too. Most commonly, the role of the school and schoolfriends was discussed: the teachers are not capable of making technology interesting, the male hackers give computer technology a negative image, and among female friends there is no talking of going into technical education.

> Suppose you're a girl whose dad, or even better whose mum, is a technician, engineer, or academic within this area. At home, those girls, as far as I understand, have a very natural, relaxed relationship to IT. But when they get to school and find themselves in the normalising value system, so to speak, which they get from their schoolfriends, IT becomes less interesting again . (1611L)

The female reformers could recount situations from their own school years where they had found teachers who had affected them in one way or another. Men had a more overall impression that schools have an effect.

There were even descriptions of characteristics of women which make them believe that technology is not for them. These descriptions can be divided into three categories: 1) girls have a broader perspective and world view than boys and think that computer engineering is too narrow a field to be engaged in; 2) girls want to have a social life both at school and at work and outside it, and do not expect that a career in engineering will give them an opportunity to that; 3) girls are cautious and afraid of computers.

It was said that girls are not interested in tinkering with computers or other technical devices. Girls want to use computers, and are only interested in them as long as they can see that computers can be something useful. Girls were said not to be interested in a theoretical education either. They were described as wanting to see the connection to practice all the time. Girls were also said not to be satisfied to work with details without seeing the whole.

> A little girl is not satisfied with sitting and poking around with a gadget just because it happens to be there. Instead, if we generalise, she most often wants to understand what it is used for, by whom and why. (1611L)

The second explanation was that the image of a computer engineer implies working alone at a screen, and this is not attractive to girls, as they like to work with people. In addition computer engineering as a profession has an image as requiring a lot of commitment and is not attractive to girls, who give higher priority to personal relations outside the workplace, especially their family. This was regarded as a false image but nevertheless one which guides girls' choices of profession.

> Then again, we believed that giving them computer labs at school would make it, but boys took over there and could work all night. So naturally, when you're standing there, making a decision, you feel that I'm not going to be one of those who sit day and night, studying computers. So this means that we have not got our message across about what it means to do computer studies, to work professionally within the area. (1917L)

The third explanation for the lack of girls in computing was girls' being insecure and intimidated by computers themselves, afraid of not being up to the standard during the education or of treading unknown terrain.

> What we did was to speak in general terms about engineering education and science education, and what I tried to say was that they shouldn't be afraid. The shouldn't be scared by the word 'technology'. (0601L)

In spite of all the reformers at LiTH coming with some explanation, the issue still seemed to be quite incomprehensible for many of them. An illustration of the perplexity for the incomprehensible preferences of girls was presented by those two male interviewees who came to think of teenage girls' interest in horses compared to teenage boys' technical interest in mopeds and computers. There was no explanation for why girls are not interested in "hacking" and no explanation for why they enjoy riding. This seems to have led to an assumption that girls' interest in horses and their lack of interest in computers are two sides of the same coin, which has not yet been defined.

While the majority of the explanations were founded on the conception of girls' special characteristics, even some structural explanations were given, such as the masculine image of computer engineering, the numerical male dominance in the education, or the practical problems for women to work late hours. Some female reformers talked about computer games which introduce boys, but not girls, to computers. Other female teachers referred to the overall cultural context, the media image of women, especially in advertising, the ongoing discourse about family vs. working life and the general attitude to higher education in Sweden.

Common to most explanations were their consequences for the reform work. If the reason why girls do not apply for computer engineering are some characteristics of girls, there is not much an educational reform can do. If girls believe that computer engineering is a narrow field with little contact with human reality or if they believe that being a computer engineer means giving up human relationships, then the best thing to do should be to correct their perceptions. The reformers tried to do this by introducing more social sciences content and introducing group work, but they were uncertain whether they would manage to get this message through to female students. And if girls during their upbringing have learnt to see themselves as non-technical and incapable of becoming engineers, then it is their upbringing that should be changed.

It was a common opinion among the reformers that a university of technology is not the right agent to change the gender balance in computer engineering. The work should be done much earlier.

> I would like to believe that it is a question of cultural values.... The little I have seen seems to suggest that the attitudes, values and norms which steer students' choice of university education, they are established very much earlier. So I don't think you can count on going from 5% girls to 50% simply by offering a better engineering programme. Because I believe that many have already made up their minds. (1611L)

The lack of confidence as to the official ambition of the LiTH programme of attracting 50% women could be based on this kind of opinions. Only two of the reformers believed in the official goal of the programme. Women were somewhat more confident, in general believing in 30-40% female students, while males believed in 20-25%.

Women's situation in the present education

When asked how the female students at present find their situation, especially their social situation, half of the reformers at LiTH did not express any opinion. Many of them did not really know. Practically none had any first hand information on the issue. They had not simply gone to the female students and asked them.

> I haven't spoken to any of them about it like that. The only one I spoke to a little was XX. I happened to be on the same flight as she was and then we spoke about her reactions during her studies and afterwards... but she's really the only one. I haven't spoken to the girls...I haven't thought about how they see their studies here. **What did you learn from XX then?** ... It wasn't really related to girls at all, more a question of how teaching undergraduate studies are appreciated within the institutions compared with research. (1311L)

As to the social situation of the female students, those of the LiTH reformers who did express an opinion said that the few women who come to computer engineering adapt quite well. The basic idea is that female and male students are treated the same way and thus there are no big differences in their social situation. That leads them to behave similarly, too. Female students were said to resemble male students, and there was said to be no significant differences in the social interactions towards other students. At the same time the reformers stressed the positive influence female students have on the behaviour of the male ones. Just one female in a group of males was said to make a tremendous difference.

It was said that those women who find it hard to adapt drop out at an early stage. Consequently, the female students persevering in computer engineering were seen as enjoying their studies and their social life. Even when the need to adapt to the male environment was commented on, it was not seen as a big problem - at least not for those who manage.

> If you get in and things go well and you manage well, then you feel very positive. On the other hand we have some drop-outs in the beginning and there is always some unrest in the beginning of a program... But if you get used to the system, get through it and graduate, then you're generally very positive. But then, of course, you have succeeded. (0917L)

Male interviewees more often than female expressed an opinion of female students having problems with the social situation, but did not explain what these problems could be, or how female students solved them. Male interviewees also more often than female said that there are certain advantages that go with being a female student at an engineering institute. They talked about the attention the female students get as only something positive, while female reformers had more mixed feelings towards it. Female reformers for their part more often said that there are no special problems connected with being a female student at an engineering institute. More often than the males, the female reformers talked about the similarity between female and male students.

To sum up, one half (mainly female) of the interviewees did not see that female students had any problems with the social milieu at the university. The other half expected there to be some, but could not tell which they were. Thus, there were no self-evident points of departure for discussing changes in the social environment of the female students. When discussing the social situation the reformers referred to the females' fellow students and did not take up the teachers as one part of the social milieu. The reformers said that they themselves do not care about gender when they are teaching, but treat male and female students the same way.

Female computer engineering students as special

It became evident in the interviews that those among the female students who persevered in computer engineering were seen as something special, different from other women. They were seen to have several commendable characteristics such as courage, and the ability to adapt, they were said to be active, successful and having found their place. They were also known as strong, tough, self-secure, dominant, and academically competent. This strength was not spoken of positively only, but also with words like cocksure or prone to dominate. They were also described as masculinized and more formalistic, but yet, all this made them "one of us". They were seen as different from the girls who are outside engineering education and whom the reformers said they did not know very much about.

The difference in academic competence between women in engineering education and other women was expressed rather in qualitative than in quantitative terms. However, an exception to the extraordinary academic competence of female students in computer engineering was said to be competence in computer subjects. There women were seen as having hardly any more competence when they start than an "ordinary" woman, that is, hardly any competence at all. Of course, women would gain in computer knowledge during their education but they were not expected to become as clever as men. The opinion that women do more poorly in computer subjects than men was certainly based on the reformers' own observations but nevertheless enforces a definition of women as not fully adequate members of the élite of computer technology.

There was a difference between male and female reformers as to their opinions of why women in computer engineering are different. There were exceptions, but in general female interviewees said that women become different during their stay at an engineering institution. They told of how values and behaviour patterns are modified when adapting to the environment at the institute, resulting in the woman being more different from other women when she has gone through the education than she was before. Male interviewees more often believed that women in computer engineering were different from other women even before they came to the education.

This can be compared to the findings among female engineering students (Kolmos, 1989; Lagerspetz, 1990; Göransson, 1995), where they complain about the masculine values and behavioural patterns that imbue the organisation and affect their personality. They are talking about the same process as the female reformers at LiTH, even if they see it as negative, and the female reformers most often took a more neutral stand. The difference can have depended on the different stages of socialization female students and female faculty members are at, or the different aims and approaches of the interviews.

Women as learners and problem-based learning

One question to the interviewees at LiTH concerned learning strategies. The reformers were asked to think over a situation where a student had to learn a new programming language, which he or she was not at all familiar with.[29] Would male and female students take on the task in different ways? While one third of the interviewees did not expect there to be any differences, the remaining answers gave a quite consistent picture of female students as being adaptive and orderly. Female students were said to reproduce more, while male students think more independently.[30]

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[29] Three of the fifteen interviewees referred to men's familiarity with computers as an important factor. The rest of the answers, however, seem to discuss learning in general.

[30] A question of technological creativity produced quite similar answers. Girls were seen as lacking boldness or not having any desire to experiment, or by having learned always to take other people into consideration. Female interviewees advocate the explanation of upbringing to a higher degree, while male interviewees are prone to explain the lack of pleasure in experimenting as a natural trait. Even if the conributions of women in technology were said to be valuable, women are not seen as pioneers and path-finders.

> If the teaching methods are conventional and the schoolmaster or schoolmistress says that this is homework, they go home and do it and then come back and regurgitate what they have learned. The boys are a bit freer in this respect. They remember some of it and can think a bit and ask more unusual questions... So I can imagine that girls find a pattern or adapt themselves to something they believe is expected of them. ... That they follow a template here, whereas a boy is perhaps more unconventional in seeking the sort of answer you want. (0601L)

Female students were said to be more cautious. This meant that they want to be well prepared before they set about a certain task, that they want to know the theory well before doing practical exercises. It also meant that female students ask for help more often. Female students were described as adaptive, orderly and cautious mainly by the female reformers. These characteristics were not described as something entirely positive.

> As girls are a little more cautious, I think they want someone to ask a bit more, want someone to show them. Boys test things more and are more adventurous. And probably make more mistakes... they girls are more inclined to stay within a sort of framework. **And they go and ask someone else?** Yes, I think so. And that may be why they don't get anywhere, because it becomes a major obstacle to go and ask someone, to find someone who can help them. They feel that they disturb people, so to speak. (0209L)

Female students were said to have acquired these characteristics because of the way they are brought up, and the female reformers would recommend them to get rid of them as they are a disadvantage in learning situations in engineering education. The male students' way of pouncing upon the learning tasks was seen as more effective in many occasions. Thus, even if studying the theory and asking for help are officially advocated as study strategies, the reformers did not always really view them that way.

When listening carefully to the reformers it was obvious that they used different words to describe female vs. male students' learning. When talking about female students they used words like clever, constrained, insecure, "zeroed", prepared, reserved, pushed aside, theoretical, adapt, regurgitate, follow a pattern, read and repeat, get left behind, see the point and reproduce, keep inside the framework, be satisfied with. Male students were described with words like free, unconventional, enchanted, fascinated, courageous, seek, generalise, try, hack, test, find the structure, see the meaningful, experiment, become absorbed, see in picture. Even if the terms used can be interpreted both negatively and positively, their context in the answers indicates that women's learning style was seen as problematic for themselves. And what was said to characterise female students' learning seems in particular to make them less suitable to be engaged in problem-based learning.

Problem-based learning was the most important feature of the reform at LiTH. It was stressed in the application to the Council and in the presentations the project leader made of the programme. It was the issue which caused discussions among the reformers and with their colleagues. That is why it is interesting to know what the reformers thought of its potential of making the education gender inclusive.

Most of the reformers did not really know. But almost half of them did not actually think that problem-based learning is specially favourable for female students. Problem-based learning is good for all students, they said. Three of them even thought that problem-based learning might be better for males than for females. Those who thought that going into problem-based learning is a good idea from the gender point of view often referred to the expectation that marketing this teaching method would attract female students to the programme - rather than expecting that it would be beneficial for their learning once they would attend the programme.

> Perhaps it's good from a marketing perspective, recruitment perspective, that by talking about PBL more girls can be attracted to enrol. I don't think they get any special favours from PBL then in the system. On the contrary, I think you have to be careful here. (1311L)

A comprehensive view on technology, the applicative aspect and concrete problems were seen as possibly attracting female students in PBL. The possibility for more self-directed learning was also mentioned as gender inclusive, if women actually do have other preferences as to course content and learning strategies. And, of course, working in groups was seen as something that should appeal to women. However, working in groups was also seen as a problematic aspect of the teaching method. The risk of male students dominating in the groups was mentioned.

This illustrates the confusion between making a gender inclusive education and recruiting more women. As the reformers really did not know of any criteria for gender inclusive education, the percentage of women recruited became the only relevant criterion. Of course the reformers also hoped that female students would enjoy their education and not drop out, but recruiting them was the primary concern - and if problem-based learning could help that and provide for a new pedagogical context, it was worth trying.

Chalmers

The Chalmers team was not interviewed extensively about their conceptions of women. However, they were asked why women should be recruited to computer engineering and their answers differed from those at LiTH. During the interviews there even emerged some other differences in their conceptions, compared to those of the LiTH team. These differences point out to the effect that the daily context, and partaking in the reform work in particular have on how female students and their role in engineering are conceptualised.

There was a difference in the emphasis of the different reasons for recruiting women into computer engineering. While practically everyone in the LiTH team mentioned the importance of female perspectives in the field of computer engineering, this was expressed by fewer reformers at Chalmers, mostly women. Conversely, the effect of female students on the social climate in the institution, while mentioned by the interviewees at LiTH when asked about an imaginary future, was mentioned in some interviews at Chalmers as the most important reason for recruiting women. Women were seen as an element improving the social climate among and the behaviour of the male students, and more women would be an even more positive element. The use of girls to disciplining boys, which is common in school (Einarsson & Hultman, 1985) would be welcome even in engineering education.

> At the level of students, I think we're going to see changes in the way we party, perhaps. Girls are generally a bit more mature in their attitudes than boys are, even at this age. And nowadays you notice that the students are a little bit younger... That finds its expression in the fact that they don't party any more, they booze... and we're beginning to get more problems with vandalism and so. I believe that if we get more girls, things will quieten down somewhat. (1712C)

At the same time, especially the female, but even the male reformers at Chalmers took up the male dominance in the social life among the students and acknowledged it as a problem for female students - in contrast to the LiTH team, where these aspects were not regarded as problematic.

> This project is being carried out in a very male context. **You mean there are a lot of men, is that it?** Not just a lot of men. They are big and macho and they do male things, such as plays with men only and secret societies for men only...just being here and looking at them, they are loud and they take a lot of space. It would be very difficult for a petite little girl to be seen in this kind of environment. (0211C)

Thus, female students were seen as both improving the social climate at the institution and suffering from it. The greater emphasis put on both of these issues at Chalmers probably mirrors the different approach taken by the project team. Another aspect where the reform context can be seen to have affected the conceptions of the reformers is another reason for recruiting female students, which was not mentioned at all at LiTH: The quality of education will be much better, if the percentage of women increases, as women have greater demands on their education. This was one of the basic ideas expressed by some members of the core group:

> ... there are rather few girls who want to get in here and they are strong girls. So if they meet resistance here, it is easier for them to see the faults than it is for boys... the girls who apply have always been best in class. When they come here and suddenly are no longer best, it is a setback for them. But the girls who come here are strong and have been able to assert themselves previously, and they are the ones who speak out when things don't work. Whereas many boys who come here have simply drifted with the tide. (0514C)

Women were said to ask for more of the practical use of knowledge, and especially be interested in applications which easily can be seen as benefiting the mankind. While girls were said to be more socially oriented than boys, they were at the same time said to be more insecure, not wanting to ask questions on lectures when many others are present. That is why they dislike lectures and would prefer group work.

A reason for the belief of female students as demanding, as well as the conception of the problematics of the male-dominated social climate, can have been the unusually outspoken group of female students which had started their education the previous autumn, just in the right time to get engaged in the reform work together with the teachers. It seems that when talking about "female students" and educational reform quite a few of the Chalmers reformers more or less referred to this group of students, which made their basic conceptions of women to differ from those of the reformers at LiTH. This is one of the aspects where the agency of this minority group seems to have made a considerable difference in the reform work.

The reasons for girls not choosing engineering were even at Chalmers seen to be found in their upbringing. However, at Chalmers the bewilderment and incomprehension were not as evident. Instead, an awareness of the reciprocity of the situation was expressed more often: it is not only that girls are brought up the wrong way, the education is truly wrong from their point of view.

Even if the more probing questions about the characteristics of female students were not posed at Chalmers, in different contexts in the interviews the view of women at Chalmers as different from other women showed clearly.

> But, of course, we girls who do computing, we are very dominant or very strong... it's also common among girls that some go over to being some sort of third gender. (0505C)

Among the interviewees at Chalmers in general fifteen women out of the hundred students, instead of the present 7, was seen as a satisfactory recruitment result. Even 20 women was seen as possible, even if optimistic.

Summary of Chapter Nine

In this chapter the statements of the reformers are presented as if it was not a question of individual persons, even though there was naturally a variation in the answers to my questions. But the aim of the chapter has not been to account for the variations in the conceptions of the reformers. Rather, the aim has been to draw attention to some undercurrents which can be discovered in a sufficient number of the answers to justify an expectation that they play some role in the work of creating gender-inclusive computer engineering education.

As the interviews were made after some months' (at LiTH) and more than a year's (at Chalmers) work in the reform groups, the answers had been influenced by the work. At Chalmers there was more unanimity among the answers concerning gender, while the answers at LiTH were more divergent. The differences between the

LiTH and Chalmers teams illustrate the fact that not only reformers' private perceptions affect the reform work, but that they themselves can be affected by partaking in this kind of work.

The discussions of women's learning style illustrate stereotypical assumptions of women which prevail, often unconsciously, and are not always in accordance with the person's official opinions. Underlying conceptions, which are not brought out into the open, make the task of adapting the education to women confusing. If the underlying conception of women's learning style is negative, the whole task of adapting an education to suit women may imply a risk of deterioration rather than improvement. The reformers at LiTH were very engaged in introducing a teaching method which many of them did not believe was beneficial to women's learning, but which otherwise was regarded as promising.

The conception of female computer engineering students being different from other women is an example of handling the breach of the gender contract the very existence of these women represents. When women break into a male dominated area they disturb the gender balance, but when they are defined as something other than women this disarrangement has seemingly never taken place. A majority of both male and female interviewees adhered to this definition of female computer engineering students being something other, more masculine, than ordinary women (and defining, consequently, also the female reformers as not-quite-women). But it was only at Chalmers that some reformers touched upon the consequences of this for the reform work.

Transforming technology as a reason for recruiting more women could be an indicator that the reformers want to recruit ordinary women. This reason was mentioned by all LiTH reformers and many of those at Chalmers. At LiTH it was stressed by the project leader, while the reformers, when discussing the issue, really did not seem to have thought it over. They had no examples as to what these perspectives might entail and they did not envision women in positions where they really would transform technology, but rather expected that women would supplement areas where their assumed special characteristics, such as sociability, could be of use, and continue leaving "pure technology" to men.

If the vision of women transforming technology is bracketed, an important reason for recruiting female students, which can be found in both the LiTH and the Chalmers answers, was the belief that recruiting women will make it easier to conduct the pedagogical reform. Women with their social competence would improve work in the PBL and project groups. Women could ask the questions men are afraid to ask. Women would find the material and the perspectives which are needed to widen even male students' outlook. It would be easier and nicer to teach, because the sole existence of women would control the behaviour of men. At Chalmers women were seen as having an additional asset of advocating continuous reform of the programme and in that way helping to create an education which is better for all - even the male majority.

Thus, in general women were seen as an asset in the environment. The basic idea was to supplement technical education with social, societal and human aspects, supposedly advocated by women. But the prevailing gender contract of separating the sexes and the normativity of the male shows itself precisely in this dichotomic thinking about technological vs. human issues, where technology is represented by men and humanity by women - and where technology is seen as the norm in engineering education.

10. Work in the planning groups

This chapter looks at what happened when individual faculty members, everyone with his or her preconceptions, worked together in reforming computer engineering education. The major part of my data that this chapter is based on comes from observing the LiTH team, even if the interviews at LiTH also are important. To state the results shortly, the ambition to make a gender-inclusive education was hardly visible in the planning process. The topic of almost all discussions was problem-based learning and integration of the subject matter.

From the interviews at Chalmers it can be concluded that the ambition to create a more gender inclusive programme was carried out to a greater extent there. Comparing and contrasting the results from the two universities I come up with three factors in the reform teams which constrained the ambition, stated in the project descriptions, of creating an educational programme which would be particularly beneficial to women. These factors are 1) competing interests - the interest of the team members in pedagogy rather than gender; 2) lack of knowledge - both on women and technology and women and engineering and on the societal subjects women were supposed to be interested in; 3) the double burden of the women in the team - both as representatives of their sex and as representatives of their department or discipline. All these affected the two teams differently. A major influence on the work was executed by the institutional (and societal) context, which is described in the next chapter.

Competing interests

In the interviews at LiTH it became evident that the reformers were not engaged in the work primarily because of their interest in recruiting female students, but rather because of their interest in pedagogical reform. There were some who sought out the group, mainly because they saw a chance to be engaged in curriculum transformation, while others had been asked to partake by the project leader, because their competence was needed, or because somebody was needed to represent their department - or sex. Personal motives for partaking in the work were very common: it would be fun, interesting, exciting to see how a new engineering programme was created and to be part of the process.

> Why am I sitting in this group? Because ever since I started teaching… I have been extremely irritated by what we do at the institute of technology. I think this way of working is substandard quite simply. (1611L)

> They asked me first. And I was interested. I thought it would be fun to see how a programme took shape. This thing about girls or not doesn't really matter to me. (0209L)

There was a difference between the answers of men and women at LiTH. Practically all women mentioned their sex as a factor in their engagement in the reform. Some were asked to partake because more women were needed in the planning group.

> I accused the one who recruited me of doing so just because I was a woman, and he said: "Oh, no. It has nothing to do with that." But I have learned that of course it had to do with it. (0601S)

Of course, none of the group members was opposed to the aim of recruiting more female students. Some of them, both male and female, had been engaged in gender-equality related activities before, sitting in gender-equality committees, or being involved in projects for recruiting girls. However, the main reason for most of the group members was to better the pedagogy, rather than make the education more gender-equal. Many of them expressed a suppressed need which would be fulfilled by engaging in the planning of the programme. They described in lively terms the problems with the present education, problems with teaching methods and teaching quality, but not problems with gender issues. When asked about this, they stated that a better education automatically meant that it would better for women, too.

At LiTH the project leader saw the project as a possibility to realise ideas of pedagogical reform which he had cherished for some time:

> The background is this big meeting in Lund arranged by the Council for the Renewal of Undergraduate Education … the faculty thought that I should go. I have always been interested in problems about women and men, so I went and I sat there and listened and thought: "Yes, this could be something" that I could get involved in. And I thought to myself that this thing is so big that if I do it, I also want to launch two other things that I have felt for a long time…One is to try to get a broader… I think it's too narrow… and the second, or third, is that for the past four years or so I have been convinced that PBL is the only real alternative…So that's the way it was, I literally sat there and listened to lectures

> and thought about the fact that this could be something. I also think that female students…work in groups and find the problems themselves and penetrate them from different directions. And I think that girls are attracted to broader programmes ... **So recruiting girls sort of legitimised your realising the other two things---** Yes, you could say that. 'Legitimise' is probably not the right word; rather that I, that it makes it possible for me to do it. PBL is an enormous effort… PBL is much more difficult within the present framework…So here I saw the chance that if I was to create a new programme, this was much easier. And that's why I got involved in this. (Project leader, LiTH)

One of the team members also talked about the possibility the grant gave for making radical pedagogical reforms - even though he believed that the project leader's interest primarily concerned gender.

> My interpretation would be that this was a neat way to get money for something that had other underlying reasons actually. Then, of course, I know that /the project leader/ or at least I think that /the project leader/ still believes that this is the main goal. Simply to attract 50% girls. And I don't believe , to begin with, we are going to succeed with this for other reasons. I think you will have to start in fifth class at school if you want things to happen. Secondly, it doesn't matter a bit because we're going to get a damn good programme. And when the money runs out, it runs out. In any case we won't have to pay it back… no. I think that the main aim is the pedagogical. (1611L)

The basic interests of the project leader were decisive in the project, as his influence in his team was considerable. The original group was hand-picked by him and trusted him. They were enthusiastic and engaged, because the project leader was.

> Actually, if I look at my real motives here and be really honest and put my cards on the table, it has mostly been my confidence in /the project leader/ that made it difficult to say no when he asked me to get involved in this. (1109L)

The basic ideas were presented by him and adopted by the core group. He was seen as the expert in problem-based learning, and had a captivating way of presenting the method, as is witnessed by one of the interviewees who had seen him present the program at one of the departments.

> There was a bit of "girls programme and what is this PBL thing". And I noticed how people changed during the two hours he spoke. The whole atmosphere changed. I had spoken to some of

> them before and had not been able to convince them because I don't have that level of knowledge that /the project leader/ has. **No** But I mean that then I see that after two hours he has ten people who could go and recruit students for him. (2209L)

The project leader's ideas were especially dominating in the visionary first phase, lasting for almost a year, till the governmental board's hearing pressed the team to engage in stricter planning and documenting. In the beginning the team members saw the project leader as the programme personified. Later, in the more practical phase, when the content of the programme had to be defined in detail, his role became less dominant, even if it still was highly marked.

> I see the programme as such as /the project leader's/ creation insofar as he is the enthusiast, he is the driving force behind the idea. Many other people support the idea, naturally, but none of them came up with it, none of them started it. Therefore, for me, the programme definitely begins with /the project leader/ and continues with /the project leader/. Now it is self-sustaining, so if the /project leader/ suddenly would leave it and say, no, I don't have the time for this anymore, it would continue anyway. But I'd say that before the first of November it would not have worked out that way. (0720L)

The closer the planning phase came to its end the more of the concrete planning work was taken over by members of the group other than the leader, and his importance as the director of the team gradually diminished. His visionary leadership was less adequate when concrete plans had to be made:

> We have different opinions /project leader/ and I...he likes to discuss things in theory. I'm not so sure; it's great, fine and so, but if there isn't a lot of time , it feels a little unnecessary. You have to get down to concrete matters after a while. (0320L)

But in laying the basic foundation to the programme, the project leader's opinions and conceptions thus steered in the process at LiTH. They were not enforced on the group, but the group members, when joining the group, had accepted them as the foundations of the planning work. Their application could be discussed but not questioned. Most team members saw it as their task to put them into practice. This did not invite quarrelling with others working for the same aim and was probably one reason why there were so few conflicts. Another one was that the project leader was consensus-oriented and used his diplomatic capacities whenever potential conflicts popped up. As the work was quite informal and formal decisions were hardly ever recorded, it was possible to let issues drop.

For example, research which shows the problematics of group work for women, because of male dominance in groups, was not taken into account at LiTH. There was some concern about the issue of male students possibly dominating in the PBL teams. However, it was not discussed but was left for the group tutors to take care of. They were yet to be selected and trained. And group work was not supposed to be worse than traditional lecture-based teaching, even for the female students. The idea of spreading the women into all groups, even if they would be a minority in them, was presented by the project leader as natural and was accepted by the project team.[31]

Both the influence of the project leader and the consensus-orientation in the group made it easy for the team members to "forget" the issue of female students. As the project leader talked about problem-based learning in greater length than about gender, the discussions concentrated on that. The orientation towards consensus did not encourage bringing up issues which might disturb the general harmony - and as there had not been any initial discussion on how the gender part of the task was conceptualised and should be realised, it could be difficult for a single team member to know which issues might be controversial. There was no encouragement to talk about gender - it was simplest not to bring up the issue, especially for the majority of team members who were interested in pedagogy rather than gender, anyway.

In addition, students' needs in general were secondary in the planning process. The point of departure was the pedagogical method and, increasingly, the subject matter. The thoughts of how different suggestions and decisions might be received by students and affect them, often came, if they did at all, after the issues had been discussed for some time. The students were talked of as abstract stereotypes and it did not seem that the student body was seen as gender-balanced. The one female student representative could sometimes tell what the present students in computer engineering were thinking about the reforms, but the expected student body was seldom conceptualised.[32]

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[31] It was cautiously questioned a couple of times by female members, but the only time discussion started on the issue it was concluded by the project leader stating that the ideology of the programme was to spread the women to different groups to maximize the variety.

[32] One example of seeing the expected student body as consisting of high achievers is the fact that the question of what to do with students who fail their

Thus the general atmosphere in the group made it difficult to be interested in the needs and preferences of female students. Even if the overall attitude could be expected to be positive, the subject could be experienced as a bit touchy.

At least two of the female group members became distressed when they noticed the absence of gender issues in the planning process. One of them had serious thoughts about leaving the process, but chose to discuss her disappointment with the project leader and decided to continue, taking upon herself the task of flagging for gender issues in the meetings, even if she felt that this sometimes put her in an awkward position. This happened when the work had been going on for about a year. In this phase the group also got a signal from the institutional authorities that gender aspects were relevant. There might even have been other factors; in any case at one of the meetings gender issues were discussed more than before. A special working group devoted to gender issues was established.

This group consisted of four persons, three female and one male, all of them among the younger team members. They did not receive clear directives from the team about what they should be doing. They did not even receive or by themselves find a name which could be said out loud in a team meeting without some awkwardness. The constitution of the working group was succeeded by a discussion about the social climate at the institution, especially the *nollning* procedure. The main issue at the meetings of the gender group was the social climate and the main achievement was cooperating with the student organ association responsible for the nollning to ensure that the students on the new programme were made feel welcome.

Another aspect of the social climate which the group agreed was important was the question of premises, and when reporting on its work in the team it tried to push for a solution to this problem, stressing the need for pleasant working space for the students. However, the question of space was difficult in itself, and the other team members seemed to be satisfied with less satisfactory solutions. The group even discussed curriculum content and teacher training, but the members had diverging conceptions of what this would imply from a gender perspective and whether it was the responsibility of this group to take care of these issues. In the reform team there was a person responsible for the courses in tutoring

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exams - how they would be able to catch up and how failure would affect them financially - did not come under discussion until quite late in the process even if students failing exams is quite normal.

which the teachers were advised to take, and the curriculum was planned in a working group where one of the gender group members (the one who generally did not say much about curriculum in the gender group) was included. No expectations were built in the organisation that the gender group would work on these two areas. In the organisation plan set up in the autumn of 1995 the group was called "the group for social environment" and its task was to plan seminars for the teachers in gender issues, but after the first students had come and been introduced to the environment the group seemed to retire.

The creation of a special gender group ensured that something about gender was thought of and discussed in the planning process. As it reported about its work in the team meetings, gender aspects were on the agenda. But at the same time the establishing of a special working group delegated gender issues to some of the team members, and thus made it more legitimate for the others not to actively work with them.

In the interviews during the last months of the process, when some of the planners looked at it with hindsight, they adopted the opinion that women's needs had been neglected to far too great a degree and that those issues should have been discussed more.

> I can't really say that the little I have seen of the pedagogical aims and the curriculum actually reflects this thing with women to any great extent. Instead it has been more or less as I had hoped from the beginning...namely a pedagogical development at LiTH, where this thing about increased recruitment of girls will be a secondary effect. So I should actually be satisfied in some way, but at the same time it is embarrassing that we haven't done a better job....we could have done more. (1611L)

The vision of the project leader was the guideline of the group. When this vision increasingly stressed the pedagogical reform and disregarded the needs of female students, the work was steered in that direction, especially as it coincided with the suppressed needs of several faculty members.

Lack of knowledge

Another explanation, besides the project leader's influence, of the prevalence of the PBL ideology, even if several team members actually did not believe in its female-friendliness, was the lack of knowledge about alternatives, about what a gender-inclusive educational programme would look like.

> And then it was more or less only PBL... and nobody really knows how this is more suited to women or how women work compared to men. (0001L)

In the original vision of the LiTH project leader, the programme would have two basic elements: a comprehensive view on computer technology, which would be acquired by problem-based learning, and fifty percent of female students. The project leader's base of knowledge was related to the first element, while his knowledge in gender issues in relation to technology and technical education was more fragmentary and did not include very much personal experience. He commonly referred to the area as "gender roles" and often exemplified it by female and male communication patterns.

As most of the other team members were more interested in the pedagogical reform than in recruiting women, their knowledge interests were rather directed at acquiring pedagogical knowledge than studying gender issues. Another explanation can be a general ignorance about this area of research. The group members seemed to lack the awareness of the existence of relevant knowledge of scientific quality. This is well in accordance with the findings of a state report (Ds 1994:130) which finds out that universities of technology seem to be unaware of research in gender and technology and the insights it can give in issues that are in the very heart of their realm.

In the project group, some literature was distributed about the practice of PBL. As to gender and technology, there were a few references to a couple of conferences somebody in the team had attended, and a couple of books were mentioned, but discussions did not evolve around them. In the spring of the second year two seminars were arranged, one about problem-based learning and one about gender issues. The first was attended by about 50 people, both those engaged and those who were not engaged in the project, and even those who were suspicious of problem-based learning. The second attracted 16 people, many of them not engaged in the project, but coming from a department where a general gender equality project was in progress. The project team also made a study visit to Aalborg in Denmark, where project-oriented learning had been used in engineering education for a long time. However, the original plans did not include meeting faculty who were knowledgeable about gender issues[33]. Gender was not an important topic at the University of Aalborg, either.

Thus, in general, "scientific" arguments, were used very seldom. Instead, personal experience or short anecdotes could be used to highlight a point. The introductory nollning aroused discussion from a gender perspective more than any other topic. When the programme itself was discussed from a gender aspect, it was the social aspects of women's situation, rather than gender aspects in the curriculum which were talked about.[34] For example, one of the few efforts to introduce a discussion about gender in the learning situation was never taken up by the group. It was stated that it was difficult to know what to do and that the problem was one of communication and group dynamics and would be solved in the groups. The team did not seem to be conscious of other aspects of a gender-inclusive curriculum.

> M1: I can't say that I know what it means to consider two gender perspectives in my teaching. I just know that I don't do it.
> W1: There are very many amusing aspects to what I heard in Gothenburg... There was a teacher who was talking, like, the whole rostrum and " and you also understand that, don't you, little girl" pat, pat, and he wanted to take care of her. So that is a major problem. There are no simple answers, no matter what you do.
> M1: What I feel we can confirm is that, unfortunately, it won't resolve itself automatically just because we have half-gender groups and there are five of us in a room instead of thirty. It needs more than that
> M2: Half-gender - (laughter)... there's a lot that can be done. For example, female and male language. And there are courses in it, so that -
> M3: On the other hand I think we have made quite some progress by having an even gender distribution in the tutorial groups. This type of pedagogics means that they take more responsibility for the issue themselves. It doesn't solve everything, but I don't think you should underestimate what you, the effects of that part of it. (Jan 1995)

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[33] In a private conversation with one of the team members I mentioned Anette Kolmos at Aalborg, who has done research in gender and engineering education. This resulted in the project team having a session with her.

[34] In the excerpts from team meetings the speakers are simply numbered for every excerpt, and their sex is stated. For example, M1 means the first male taking a turn in this excerpt. Three dots (...) denote omitted parts which can be everything from one statement to several turns. A hyphen (-) denotes one or several undiscernable words on the tape.

The general absence of discussion on gender could thus also be explained, except for competing interests, by there being no common foundation, no starting point for discussion the same way as there was in regard to PBL, where the project leader's experience and opinions provided a starting point.

This lack of knowledge on relevant research was supplemented by a lack of knowledge of the target group more precisely. As to the female students now in the education, we have seen that the team members had not taken pains to find out about their experience and preferences. They were represented by one person in the project team. She was sometimes asked what students could be thinking about an issue, but that did not happen regularly.

As to girls in secondary school, some material was actually collected. When the team could not agree on what to call the programme, the student representative visited three classes in secondary schools to present the programme and to ask the girls what they thought would be a suitable name. The results, which also reflected some of these secondary-school girls' ideas of computer engineering education, were presented to the group at one of the meetings. However, the presentation was not discussed further. Later, when pairs of women were sent out to make PR for the programme, their experiences were reported, but their ambition was not primarily to find out what the girls wished of an education, and thus their reports hardly touched that subject, either.

So the student representative in the group even got to represent secondary school girls, and was relied on, for example, in the question of how the programme should be marketed. Her words in the working group for PR, which consisted of herself, the person responsible for PR and the two representatives from industry, weighed heavily, and her authority as a female student was relied on when one of the other representatives explicated the opinions of the group in a team meeting (which the student representative herself on this occasion did not attend):

> M1: XX had strong opinions at the meeting. She said two things. They were: don't say that this is for girls, and don't say that this is computer studies, just let the content make sure that it sells so well that girls come, OK. She was very exact and repeated this several times. (May 94)

Something that became evident in the team meetings at LiTH, especially for me as a social scientist observing them, was the lack of knowledge in areas of social sciences and economics, which were to be important in the new programme and which women were supposed to appreciate.

The original idea of the project leader was to supplement the ordinary computer engineering education with "non-technical subjects" - communication skills, psychology, sociology, management skills, economics, societal aspects of technology and the history of technology to the equivalent of one term's studies. These knowledge areas were represented in the group by a single female representative - the director responsible for these subjects in engineering education.

The subject matter, its relevance, place in the education and possibilities for integration with other subjects were main topics of the team meetings apart from PBL as a teaching method, but this did not apply to the non-technical subjects. The social sciences representative presented her ideas, talking quite fast and handed out her plans, but she seldom got much response. The leader acknowledged her, she might get a question, but then the team signalled acceptance and went on talking about other things. Much of the time she was the only non-engineer in the group. Except for presenting the plans she was responsible for, she quite seldom partook in the conversation.

This was true during the time the programme was still in a somewhat visionary phase. The information that the programme could not be prolonged, as the project leader had planned, and the need to make more concrete course plans changed the situation. Cutting the planned amount of social sciences and communication content was a question that was in the air. The social sciences content which had been accepted without discussion was now seen as taking a lot of space which was needed for traditional subject content if the programme was to be compressed. However, the project leader was unwilling to cut social sciences and communication, but rather suggested cutting everything a little, with the argument that by integrating subjects the programme would avoid teaching some things twice in different courses, and thus space would be created. From there on there were recurring discussions on the place and space of the non-technical subjects in the curriculum.

> W1: But I don't think you can get an engineer with the same knowledge as a computer science engineer if you have 30 credits non-technical subjects. You just can't. So I'd rather cut down there.
>
> ...
>
> M1: I think we have to think about what these engineers should know. What they should do with their knowledge. As a starting

> point, I want them to be mathematicians, systems engineers and computer scientists.
> W1: But now they'll be just as much social scientists ... I also think it's a bit risky with so many credits. Because in the other subjects, in maths and physics and everywhere, they can write essays, make presentations and so on, but perhaps there are no credits. But it would still be a much better education. I don't think it needs to be as much as 27 credits.
> M1: There's an awful lot in those credits. There's a lot of things.
> M2: /Social sciences representative/ has said that she could come in now and then without credits, as well (April, 1995)

This discussion is typical in showing the general mixing up of communications skills with social sciences content and the social sciences representative personalising the area. As the communications skills were planned to be taken up in several contexts all through the education, the need for devoting sizeable curricular space for social sciences was questioned. In the end, when the programme started, the non-technical content had been cut down from 29 study weeks (out of 180) as originally suggested to 20.

This lack of interest in the social science content could be characterised as just lack of interest. But the questions and comments which were made to the social sciences representative also revealed that there was only a very vague conception of what these studies would imply for the students and how large knowledge areas lay behind them. As Swedish engineering education is very technically oriented, relatively superficial knowledge on social science in general can be expected among faculty at Swedish universities of technology.

For example, one way of integrating the social sciences content was not to let the studies in leadership appear on the curriculum in the form of study weeks but leave them to be catered for through student groups' conducting a major project - that is, seeing the knowledge area of management studies and psychology of leadership as a practical skill instead of a knowledge and research area. The goal of the five weeks' psychology course was to "understand the human communication", meaning literally that, and thus revealing a lack of insight into the number of relevant areas of psychology, and the vastness of the area of human communication.

As practically all of the members of the project group had a basic knowledge of engineering subjects, they were able to discuss them. The social sciences representative had practically no one to discuss her area with. The common knowledge base which is a prerequisite for communication simply did not seem to exist. Her lone position in the group also meant that she became the sole representative of all human and social sciences in the group, and the other group members were not impelled to understand the size and diversity of the area she represented. The team members were not quite capable of envisioning what this subject matter was and what its concrete contribution to the education of the students would be.

When the work had been going on for a year, and the plans were getting more and more concrete, a question of engaging additional social science representatives to the special group for curriculum planning was posed by the social sciences representative. However, this was not seen as desirable by the other members. Their argumentation towards the social sciences representative emphasises the team's opinion that the social sciences content has been well catered for, even if in this context for the first time a team member expresses a need to know more about the area.

> W1: If we take in someone else they'll still be one step to the side anyway, the same role as you have.
> M1: I think you have done a very good job, in that even though you are a communications person, I know that, you have still represented the other things…
> W1: I have a concrete proposal and that is that the way it is with the other subjects, I think we are fairly aware of what could be included… but I wonder if we are equally agreed on the conceivable non-technical subjects. There I would really like to have a little list so we could help you monitor what has to be included and what might be dropped ...
> W2: I could do that for the next time. A little list of what might be possible, which subjects would be suitable.
>
> ...
>
> M2: With regard to the non-technical subjects, I don't have a feeling that we have dealt with them too little…. I think they've been there the whole time in my mind in some way but I'm not sure how. (Feb, 1995)

When the programme had started, the group for curriculum planning became established as an official organ for curriculum issues. The social sciences representative pointed out that she thought it important to be included in this group. The opinions of the team were divided – one argument against the social science representative being included was that the group should be kept slim - but there were enough voices, among others the project leader's, for her inclusion and so she became a member of the group.

The idea of having much non-technical subject content originated from the project leader, and his argument that this was needed to make the students generalists, able to communicate with different professional groups, was accepted. It could be expected that the team members would see these areas as especially relevant for the female students, as they believed (as stated in Chapter 9) that women reject the narrow technical perspective of engineering education and will most often work with people in their professional life. However, this was not mentioned during the discussions of the place of social sciences content on the programme, either by the project leader or by the team members.

The lack of knowledge on alternative curricular areas is reminiscent of the study of Rasmussen & Håpnes (1991). They found that female students, when becoming engaged in educational questions, did not question the curriculum content, but made suggestions about teaching methods, which were experienced as far too anonymous, ineffective and generally unpedagogical. While Rasmussen and Håpnes confirm the problems with the teaching methods, they also explain the concentration on these aspects by a hypothesis that the apparent satisfaction with the curriculum content actually masks an incapacity to conceptualise another kinds of curriculum content, because there are no opportunities during the education to question the transmitted view of technology as the only possible one.

The three issues, lack of knowledge of issues concerning gender and technology or gender and learning in general, lack of knowledge regarding the present and future female students on the programme and lack of knowledge of those subjects which were supposed to interest female students may seem too diverse to be put together. My starting point here has been my curiosity about the discovery that academic staff, who normally base their professional life on science and facts, undertake such a major project as planning a new gender-inclusive educational programme without assuring themselves of a relevant knowledge base. I have proposed a couple of explanations - there was not enough interest, as the reformers were interested in pedagogy rather than gender and there was not any awareness that there was actually very much to know. There can even be a third explanation for the lack of knowledge: Lewis (1993) states that the faculty in an engineering education institution are often not trained and accustomed to reflecting on their own practices, which also makes gender reforms more difficult. This is partly because, as Lewis remarks, teachers are promoted because of their disciplinary knowledge, and not because of their teaching knowledge. They are supposed to be able to plan their lectures, courses and, obviously, whole educational programmes on the sole basis of their disciplinary competence.

The position of women in the planning work

At LiTH the reform group originally comprised about the same number of women and men. This soon became an official doctrine, called Noah's principle - half of the team and the subgroups should be female. The team took some pride in fulfilling this, and the project leader readily pointed it out when talking about the planning work. It was expected that a high percentage of female members would guarantee female students' interests being taken into account. Women were definitely seen as an asset in the group. The project leader talked (with the other group members quietly consenting) about the new aspects which the female members brought into the work of the team. However, what these aspects were, was never really specified.

> **The project leader's principle that there should be an equal number of women and men who plan, do you think it has any practical significance?** I don't know about the actual planning. Yes, it has I suppose, men and women think in different ways... I can't say anything concrete that would have been different, but I believe strongly that things will be much better for the girls if it continues the same way.(0320L)

While this is a reasonable assumption, it became evident at LiTH that even a gender-balanced planning team did not guarantee that female students' needs and preferences were discussed. General studies in power balance and group interaction can explain part of this: even when women represent fifty percent of a group of people, they often do not do fifty percent of the talking and do not have fifty percent of the influence. This is likely in particular if the hierarchical position of the women is inferior to that of the men or if the women are younger. And because women high in the hierarchy in universities of technology are almost non-existent it can be expected that, for the foreseeable future, if women are sought to work with major reforms, they will be on lower levels of the academic hierarchy, and thus have less influence than men.

> A little disadvantage, and now I might be sticking my neck out, is that we women who are here, apart from XX, are very young. But I don't know if I am so young any longer... But I feel young. Yes, of course XX and myself and NN are senior lecturers, but we are not old senior lecturers, we haven't a great amount of experience and authority... So it can be a disadvantage , the fact that it is difficult to find women, because then the ones you get are very young. (0601L)

Another reason which became evident in the team meetings and which can be expected to affect this kind of reform work in technical universities in general are the token mechanisms to which the women in the groups had learnt to adapt and which restricted their contributions. Even if the gender distribution in the planning group was equal, the whole context in which these women functioned professionally was not. The first indicator that the situation was not balanced, in spite of the numerical equality was the answers to the question as to why the reformers were engaged in the work, where the female members mentioned their sex as a relevant factor, besides their professional qualifications and sometimes previous connections with the project leader, while the men only mentioned their professional qualifications and connections with the project leader. Even when the women said that they had not represented the interests of women, they seemed to think that they should have done it.

> **What has your role been, what would they have missed if you hadn't taken part?** ... It's hard to say. Now we have actually just discussed things from the standpoint of the subjects... And there I can't say that just as a woman or as a person I have had more influence that anyone else representing a subject. I have fulfilled my role as any other representative for the subject would have done in my place. But since I am a woman I have also, at least at the bigger meetings, even if it hasn't been discussed, there is -- no, I can't think of any good way to put it.(0601L)

That women, who felt that they had been recruited to the group because of their sex, believed that they were expected to advocate women's standpoints is hardly surprising. However, it shows that in spite of the numerical balance both sexes were not represented on an equal basis, but it was women who represented their sex among men.

The wish to recruit female students was not necessarily greater for all the female team members, compared with the males. As stated in chapter 9, the female team members saw themselves as not very different from the male ones. In the interviews they expressed the further problem of not seeing themselves as able to represent those female students who were to be recruited by a reform, as they felt themselves as belonging to another category - they had not needed any reforms to apply to computer engineering and had accepted the education as it was. Both by themselves and the men in the group the female team members were defined as different from normal women.

> Those of us who have been here are already a little (laughter), we are already damaged for life… I don't know how the girls think. I have begun to wonder whether I'm a girl. (0320L)

> XX, she is so…. I don't think of her as a woman in the same way as others. No, but she is, I suppose… in one way she has grown up in a man's world. Learned how to assert herself in that milieu, I imagine. (1311L)

The defining of women as masculine had direct consequences for the planning work. With this gender definition it is understandable that the women did not feel capable of representing the female students-to-come, and that could be one reason for keeping quiet in the planning meetings. Further, according to Bourdieu & Passeron (1977), the very fact that some individuals from the dominated class succeed in the educational system contributes to the misrecognition of the reproductive task of the system, and makes success and failure in general look like individual achievements. The existence of women who had succeeded likewise may have contributed to the difficulties of the team, and not least the successful women themselves in seeing gender as a structural problem which should be attacked by the team.

However, in spite of seeing the women as not-quite-women, the male members of the team seemed to rely on the women to take up gender aspects. Women were both seen as advocating gender issues and as being important for the functioning of the team because of this.

> **Do you notice that there is a discussion?** A little bit. but not like that. No, up to now there hasn't been such an awful lot… I suppose sometimes someone points it out, so to speak, some of the female participants. I wonder if it wasn't XX, NN, or someone like that. But no, not so much. But it is, so to speak, it is an important idea here, so to speak, that there should be a lot of women. (1911L)

So, the men in the group expected the women to take up the interests of the female students-to-come, while the women did not feel that they had any inherent knowledge of those students, if they were expected to be different from the ones now in the education. Most of the time nobody felt sufficiently capable of taking up the interests of the female students.

Another problem was probably the normal token behaviour of not wanting to stand out and be identified as a member of the minority group. Talking about gender in the team meetings would have meant just that. As gender issues were most often not discussed in the meetings, talking about them did stand out as something special. So, in addition to feeling that they could not answer the question of how the programme could be made gender - inclusive, the female team members had reasons for not always wanting to answer that question and advocate women's points of view.

Another token behaviour, the reluctance of changing the institutional conditions in favour of the minority group, was not directly recorded, as the aim of the programme was to recruit more women. However, many of the women had a complicated attitude to recruiting more women, and did not want to stress the gender aspects in the reform. The female students who were not engaged in the planning were said to be even more negative to stressing gender. The women, just like the men, stressed that the programmes should not be labelled as programmes for women and that both sexes should have same conditions.

> Of course you should also think about the girls, but just as much about the boys. (0320L)

Thus, the male reformers conformed to the norm of not discussing gender in the meetings. They did not even need to feel that it was expected of them, as the women were perceived to be in the team precisely for that purpose. It was expected that the women in the team would change their conduct from being de-genderized faculty members to being women representatives. This did not happen, but the women continued to keep their inculcated role, defined as "not-quite-women". Just walking into the meeting room did not make them throw away the role which they had learnt during several years' socialization at the institute and which their professional life was built on.

Thus, when asked about concrete examples of what difference involving women in the working groups had made, many team members found it difficult to point out anything. It seems that the reformers expected female aspects to be expressed by the female members rather than actually hearing them being expressed. They leaned on the common opinion, reported by Farish et al. (1995), that including women in working groups guarantees that gender aspects are attended to. Women seem to have been markers of equality in the group rather than contributing with something concrete. Hocking (1993) points out that especially in engineering education, defining gender reform as women's responsibility does not take into account the historical male roots of the present situation, nor does it recognise the difficulties for reform by a group which consists and will for a considerable time consist of minority members in the organisation.

Even at Chalmers many of the Pedagogical interest, knowledge and women's position in the Chalmers team

Reformers were interested in pedagogical reform - even if they sounded more apologetic when saying this than the reformers at LiTH. The need to guard personal or professional interests was also expressed more often, which is understandable, as the team were reforming an existing programme, where many of the reformers more clearly had interests to defend. The reformers were representing their departments or subjects - at the same time as many of them also welcomed the possibility of doing something about the education and felt that they had things to contribute to making an education which would better cater for the students' needs. Many of the reformers at Chalmers were recruited among students. For them the possibility of improving the education also had first priority.

An interest in recruiting more women was expressed much more often, both by women and by men, at Chalmers than at LiTH, as an addition to the pedagogical reform. While the LiTH reformers mainly complained about the present teaching methods, some reformers at Chalmers also pointed out that the scarce number of women makes Chalmers a duller workplace than it otherwise would be.

> The first thing that struck me was that for the first time in all my time here something concrete was being done, and with a clearly expressed aim... Then of course there are other reasons, that go far back in time, if you look at a work place like mine... there are about sixty of us here, I would guess. Four are women, three of whom are secretaries, and one is a postgraduate student. So the way it is, I think that in one way this is a very boring work place (1501C)

At LiTH the project leader's interest in pedagogy was an important factor in directing the reform work away from gender questions. At Chalmers the situation was different: the project leader himself carried the gender issue along, and the work was not perceived as realising a vision, but as a necessary reform in the organisation.

Even for the Chalmers project leader pedagogical reform was very much in the foreground. But the task of recruiting women had another kind of emphasis. The need to recruit women, to do something about the gender balance was expressed more clearly as a concern for the reform work.

> There are three reasons, actually. If you take them in the order they appeared, first, it has been going on for quite some time, there has been criticism of the fact that there was too little freedom of choice in the programme. Even before I was made responsible for the programme work had begun to increase freedom of choice. The second, that was when they evaluated computer engineering programmes, the national evaluation... Above all it produced ideas about possible improvements and so, and it is more or less expected that you tackle these problems...It says also very clearly that more women are needed, that we have to increase our efforts to recruit more women. But the direct reason for this project is of course the Council for the Renewal of Undergraduate Education... So we understood that if we made this type of effort here we would get good support from the board of Chalmers, we knew that from the beginning. So that's the direct reason, but then there was a feeling in the air that it was time to do something more thoroughgoing, and getting a more equitable gender distribution on the computer courses, that of course is very important .(Project leader, Chalmers)

Thus, both project leaders saw educational reform, improving the education in general, as their main task. But while the project leader and his team at LiTH got carried away by their interest in pedagogy, the Chalmers project leader and many of the members of his team expressed a more pragmatic view of the task. It was to a certain extent regarded as an engineering problem - the task of improving the education especially for female students was set by the Council and should be solved the best possible way.

In general the planning was organised by delegating different tasks to groups of people and monitoring the process by the project leader and the core group. The aim of doing the curriculum reform for the good of the female students was adopted by the core group. All the reformers interviewed were aware of the goal of creating gender-inclusive education and had been thinking of it at least during some part of the process:

> **You can talk a lot about the reform without saying anything about girls.** Yes, you can. **Do you ,then?** It was a difficult question. No, they go together anyway, thanks to the fact that it was made clear from the beginning that it was primarily designed to recruit women. (1201C)

But most of the reformers - the exceptions being mostly women - were more motivated by the possibility of improving the pedagogy, even if quite a few of them were a little conscious about gender not being their first concern. In the day-to-day work of the planners it was difficult to see that the work was done to recruit more women. Those female students who got engaged in the reform work sometimes reacted to the absence of gender issues in the meetings.

A way of reconciling the demands of female-friendliness and the interest in pedagogy was the reformers seeing themselves as creating an education that would be better for all. As women require more of their education, it will be good for them, it was argued. If girls at present were deterred from the education because of its pedagogy, another kind of pedagogy should attract them.

At Chalmers the question of whether it was pedagogy or gender which was important in the reform did not get such a clear answer as in the LiTH interviews. Pedagogical reform and the recruitment of women were seen as going hand in hand, and the question was only which of them came first:

> Actually it wasn't until yesterday at the meeting with the project leader that there was a discussion about what the aim really is. Is the aim to have more girls or is the aim to improve the quality of the programme by attracting more girls? **Yes, what conclusion did you reach?** Well, there are two camps in the project leadership. And personally, I feel that the goal is to get more girls and because that is perhaps the most important strategy in some way and it gives a rather strange circular effect. Because I believe that to get more girls we have to change the programme so that the quality is improved, in fact raise the quality because the girls demand it, in some way. Whereas the other camp believe that we should improve the quality of the programme, and getting more girls is one of the methods, but there are other ways too. The result can very well be the same , but there is a fundamental difference with regard to measuring the result, if you want to put it, see it that way. (1712C)

While the lack of knowledge restricted the possibilities of discussing gender in the LiTH team, at Chalmers there was somewhat more knowledge - both scientific knowledge and knowledge of the target group. Among the members of the core group there were those who had read something about the issue. The female vice-president who followed the work closely was knowledgeable about the problem area. After the process had been going on a few months a new program secretary was appointed with a dual background in both psychology and engineering and an interest in gender issues. His background as an engineer (and his sex as a man), probably legitimised his knowledge, so that it was acknowledged even by other engineers, who were thus made conscious of the fact that there really exists relevant knowledge which is not just a controversial and normative and thus not reliable part of social science. His performance in explicating gender problematics to leaders of other programmes at Chalmers was admired by one of the team members.

> And XX managed to speak for a long while about the core issue, about girls and girls' view of learning and psychologically and the group perspective. He is quite knowledgeable too... he knows what he's talking about. But I would have been worried beforehand that he dared to speak for so long and so much, but then -- really just in front of these technologists, right. But they were interested, it seemed. (1112C)

The knowledge of the target group can also be expected to have been greater at Chalmers. A number of the reformers at Chalmers, some of them in the core group, organised outreach activities themselves and got into contact with girls from secondary schools, while the organisation of such activities lay outside the reform group at LiTH. (Even if some members of the LiTH team visited secondary schools, these activities were much more peripheral in comparison with Chalmers.) As to the knowledge about female engineering students at their own institution, the reformers saw many of them partaking in the process.

> Whenever it has been possible, we have always tried to include one or two female students ... that's perhaps one of the main differences, I think, between our project and the others, that we have always included students... and as much as possible, female students too. And it has worked rather well, in fact, to include students, and women above all. There's only one group that hasn't had it, I think...But of late, unfortunately, there have been signs that many students feel that they have been brushed aside...I suspect that it can have to do with the fact that for the first time we are approaching an area where the teachers are used to working with this. It can be a question of how you plan a course more or less, and at the same time they are not used to having students with them in that kind of work. (1712C)

Giving the students, male and female, a chance to use their voice in the planning process (which they had to take themselves in some groups) notified the faculty representatives of their existence. Even if the students would not have had as much influence as the other group members, they were still more visible in the process, compared with LiTH.

As to women's position in the planning groups, it was impossible to reach the 50% ratio of LiTH because of the number of people involved. However, as many women as possible were engaged. Just as at LiTH it was stressed that women had to be engaged in creating gender inclusive education.

> **Has the female aspect been seen in the planning?** Oh yes, for example by trying to have women in all the work groups. If they are not present, they can't make their voice heard either. (1401C)

As there are no group observations from Chalmers it is impossible to say to which extent token mechanisms were at work there. The definition of the female reformers as special could be clearly traced in the interviews, so the underlying gender contract seemed to be similar. But there might have been two important differences:

First, talking about female students' needs might have not stood out as quite so exceptional as at LiTH, because the aim of recruiting female students was continuously pointed out, even if it was not always thought of in the concrete measures. This would mean that it was easier for both men, and even for women to take up the issue.

Second, it is possible that the group of female students accomplished something that would have been more difficult for female faculty. The small group of five female students enrolled in the programme the previous autumn was different from the female students before, in that they had challenged both their male peers and the teachers. During their first week at the institute they sent out a questionnaire about the male students' attitudes and condemned some of their behaviours. While they were criticised by many students, they also got some positive response. They also sent the results of the questionnaire to the new leader of the programme, who then became the project leader. Three of the five female students then involved themselves actively in the planning of the reform, one of them becoming especially well-known and quite influential. This group of female students seemed to consciously avoid the most common token mechanisms, and chose to challenge the institution instead. Possibly the timing of the reform project was quite right from the point of view of these students. The interest in female students and their preferences may have justified a sense of being different and rebellious, and partaking in the reform work provided a channel for doing something about the dissatisfaction.

Summary of chapter ten

There were three interacting factors directing the reform work towards pedagogy rather than gender: the reformers' interest in pedagogical renewal rather than gender, the reformers' lack of knowledge in gender issues and the position of the female reformers as the expected carriers of the gender aspects in the reform. All these factors were more visible at LiTH than at Chalmers.

To start with, it can be noted that while there were many reasons for the reformers to be engaged in the work, the most common was an interest in pedagogy, rather than an interest in recruiting women. The interest in pedagogical reform rather than working for gender equality mirrors the urgent need for pedagogical reforms in Swedish engineering education. For faculty who experience this working environment as frustrating, a grant which makes it possible to reform pedagogy and curriculum is welcome, whatever tag is attached to the money. Recruiting more female students is not directly an answer to the dissatisfaction one can feel as a teacher. Really planning for female students promised lower immediate rewards for the faculty than to plan for pedagogical reforms.

The lack of interest in gender aspects among the team members contributed to the lack of knowledge of gender issues and to a tendency among male members in the planning groups to delegate the responsibility of discussing gender to the female members and to some extent even the tendency of the female members not to discuss gender. Inversely, the possibility of regarding female planners as responsible for the gender aspects gave a legitimacy to the male planners' non-interest and lack of knowledge. Lack of knowledge also restricted both female and male reformers from discussing gender issues.

The lack of knowledge was more visible at LiTH, where arguments about women's preferences, when they appeared, were most often founded on personal experiences by both the female and the male members of the group. There was also a lack of knowledge in those areas outside engineering, which were to be one of the profiles of the programme and of special interest to female students. At Chalmers the reform team was supplied with more knowledge on gender issues, even if it did not extend to all those engaged in the reform work.

The task of making the programme gender-inclusive was hardly ever discussed in the process at LiTH, and in general the assumption of the project leader that a programme fulfilling his vision would be very attractive for girls was accepted. As the reformers had no criteria for a gender-inclusive education, there was an underlying idea that female-friendliness could be measured by the attractiveness of the programme to women and that success would be indicated by the number of female students applying for the programme right from the start. Even at Chalmers the reformers expected that a better educational programme would even be better for female students. Or, conversely, at both LiTH and Chalmers there was a strong opinion that making an education more gender-inclusive is to make it better for everybody, that is, for the whole, predominantly male student body.

The ideas advocated by the pedagogical interests, PBL at LiTH and a broader education with more freedom of choice and project work at Chalmers, were seen as being well in accordance with what female students want of their education. At both sites women were seen as more socially oriented than men and more interested in broader perspectives in technology. Both assumptions are supported by research. However, other assumptions which also can be derived from research and which also surfaced in the first interviews with the LiTH team were not considered in the reforms. An assumption that the domination of the male peers in the education troubles women, confirmed by several studies, was mentioned only by a couple of the LiTH interviewees and, consequently, hardly considered in the reform group. (Even at Chalmers this problem was not seen as being of particular importance.) Another assumption the implications of which were not mentioned was the one of women more often than men wishing to be able to have social interests outside the university. Those conceptions of women's preferences which the reformers referred to were those which could easily be combined with their pedagogical interests. And for the reform teams there was no reason to question the basic ideas of the reforms. The evaluation of their project ideas as entitled to a state grant could be regarded as the test of their appropriateness for the recruitment of women.

The female reformers were expected to be more interested in gender issues than the men, because of their sex. It was true for some of them (more so at Chalmers than at LiTH) but not all. And their possibilities to express this interest were curtailed by their position, both in the team and at the institute, and, at LiTH, the way the discussions quite soon came to concentrate on other aspects of the reform. The fact that they formed half of the planning team at LiTH did not foil the token mechanisms working in the institutional environment. At Chalmers with the basic idea of gender being one aspect of a task to be executed, the position of the women might have been somewhat different. It is also possible that at Chalmers women (for example female students) with different coping mechanisms in the token position were engaged in the work.

The differences between the approaches at the two universities can partly be attributed to the differences in their origins. While the reform at LiTH was envisioned and initiated by a single charismatic leader, the reform at Chalmers was seen as a realisation of a needed renewal in the organisation.

The LiTH project leader's approach to the problem probably strengthened the imbalance between pedagogical interests and gender interests in the LiTH team, and his level of knowledge on gender issues and areas related to them might have been that which set the norm required in the work. However, these problems existed even at Chalmers, and the comparisons with the Chalmers team rather confirm that the problematics which stood out very clearly at LiTH were not limited to the one particular university or team.

The origins of the reforms were directly dependent on the institutional context of the reform groups, and the institutional context continuously affected the work. Thus, the next chapter should actually be read parallel with this one, to illuminate the work in the groups from one more perspective.

11. The institutional context

What happened in the meetings of the reformers was to a great extent dictated by the context they were working in. It created both inner and outer frames and restrictions to their work. The inner frames, (or part of the habitus), have directed some of the phenomena presented in the two previous chapters - they are the modes of acting and, here above all, thinking which are natural and unquestioned in the environment, some of the doxa it builds on. Thus, the lack of knowledge which restricted the engagement of the LiTH team in social sciences subjects or the idea of seeing female computer engineering students as tough and dominant, resulting in an incapability of envisioning the preferences of the "normal" women were such inner restrictions.

But because the task of the reformers implied changing something at the institute, making an impact on other people's everyday environment, they also confronted other kinds of restrictions. What could be thought and said in the team meetings was perhaps unsuitable outside the meeting room. The reformers did not always quite know which actions they could not take without raising objections, subtle or open, among their colleagues and superiors. Their work and their products, the new programmes, had to be accepted by the institutional environment where they were to be situated. This was complicated by the fact that they represented something disruptive – not least an effort to make a breach in a gender contract.

Some aspects of the institutional context, the outer frame of the reform work, are emphasised in this chapter. The basic issue is recruiting women into engineering education which is seen as an élite education in the masculine field of technology. The importance of status in this environment is discussed to start with. Male students and computer industry as special groups which the reformers had to take into consideration are described next. Then the role of the money, the grant for implementing the reforms, not only as an incentive for starting a reform, but also as an element in the relations between the reformers and their environment, is discussed. Finally there is a description of the special problems caused by the situation where a wholly new programme has to be legitimised and its image defined.

The observations at LiTH gave several insights into how the outer frame was handled, and the interviews at LiTH supplemented this picture. The conclusions drawn from the interviews at Chalmers were quite different in some aspects, even if there were also similarities. The importance of the institutional context emerged clearly when the situations of the two reform teams were compared.

Making engineering education - keeping it technical and tough

The reformers were very well aware of the obligations imposed on them as planners of engineering education. They were to recruit women into engineering by reforming the education - but these women still were to become engineers. The traditions and images connected with the concept of the master's programme in engineering restricted the reformers - both because they reformers themselves carried these traditions and images and thus could not visualise a very different programme, and because important reference groups' definitions of an engineering programme had to be adhered to.

At LiTH it was the project leader's decided opinion that the programme should be a master's programme in engineering and not any other kind of programme in information technology or computer engineering. A couple of his team members regretted this:

> Then of course it was almost only PBL... computer engineering with PBL. That's because we were so terribly focused on making it exactly like a master's programme. (0001L)

What the reformers could not (and because of their socialization in the environment most often did not want to) do was to create anything that differed too much from the image of engineering education and its implications, even if at least one of them felt frustrated with the implications of a master of engineering programme.

> In general I really wanted us to get down off our high horses a little and not be so obsessed with this word 'engineer'.... so that people stopped getting so terribly roused up about it being just engineers, where you have to have forty credits in steam turbine engineering and four exams within three days, otherwise you're not a real engineer... It's got to do with comparability and a seal of quality and it means so much that we can't look unconditionally at the structure and content of the education... And many of those who employ people in these technology-intensive companies, they are also engineers and they went to the Royal Institute of Technology in the 1940s... it reinforces itself all the time. (1611L)

So, in creating a master of engineering programme the reformers had to create a challenge and an ordeal (Seymour & Hewitt, 1997), and should not allow the students to intellectually wander around too much, but to put them into effective work with defined subject contents. Doubts about giving up the ideal of time discipline could strengthen other doubts about the "fuzziness" of a programme.

> There are those who question PBL, how are the students to get time for everything...you can lecture about quite a lot in a short time, but if people have to find out about it themselves, it takes incredibly more time. And that's really where the major discussion lies...And they don't manage and what's to become of them, and sometimes people think there's too much 'fuzz' and 'fluffiness', and they sit there in cosy settees and like each other and--, well, you know, people have their little prejudices. (0601L)

The programme not only had to gain acceptance, it needed more than that: a good reputation. It had to find its position in the field of Swedish engineering education programmes and thus show up as much traditional symbolic capital as possible. The reformers had to make assumptions of what kind of features would be devalued by their colleagues, not only at their own university but all over the country, and stay clear of them.

"Soft" is concept used in engineering education as a contrast to the hardships that should be inherent in engineering education.[35] "Fuzzy" is another deprecating term, denoting unclear requirements on students, easy passes, unclearly defined course content. For example, many social science subjects, where the course partly builds on what the students come up with and where the underlying theories are subject to discussion are typically "fuzzy". With the crowded curriculum, the engineering students are not seen to have time for any fuzz, but their ambition should be to take in the defined curriculum content in an effective way. That is also an implicit learning goal - to be effective in learning and work.

In many cases the discussion about how and what to reform was restricted by both the inner frame the incapability to conceive of a radically different education (at least one which would not be "fuzzy"[36] and the outer frame of expected subtle and open sanctions if the programme were not hard enough. At the same time, what female students were expected to appreciate was in contrast to this. Group work is typically "fuzzy", as no definite requirements can be set up for what the group will discuss and come up with. Societal aspects and a comprehensive view are fuzzy, too, as they cannot be grasped and defined. And even if female students in the interviews were described as hard-working and academically competent they were also described as not committed to computer engineering, but as having more "soft" preferences than the men. This implies that their attitude is not quite the one which is presupposed by a computer engineering education with a good reputation. The ideal of an engineer, educated through a tough programme, contradicts the picture of an individual who prefers the "soft" areas of social sciences and social relations instead of hard work. Even for the reformers it was hard to find a compromise in this contradiction.

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[35] The term "feminine" in itself has a "soft" connotation.

[36] It was natural for the project leader to choose his pedagogical model from medical education, as he was personally acquainted with it, and as it offered a well-functioning and comprehensive model. In the institutional context this model also had the advantage of coming from an education with a reputation of

> I don't think anyone has failed to notice that this directs itself to girls, but no one says that this is a programme for girls... And then, of course, certain people are not really prepared to stress this first and foremost. If you look at some the other programmes then perhaps there's more of an attempt to create an image that this is difficult, with lots of mathematics, but leads to good job opportunities. You want to get those who can--, yes I'm prepared to work hard, I can give it all I've got... I can't really say, either, that I myself want to reform the programme on all counts. Because I don't know what I will get; they should still be engineers . (0017L)

From the financial point of view it has become increasingly important for universities to recruit academically competent students to reduce the drop-out rate. As a fall in the number of applicants is expected with the diminishing cohorts of young people with the relevant background, it is increasingly important to get hold of all available students with the right qualifications. All institutes of technology are interested in getting female students because of the interest in securing a permanent recruitment of capable students, even if no acute trouble as to computer engineering was experienced at LiTH. Besides, it is good for the societal image of an institution to have a fair percentage of female students. Thus it could also be assumed that succeeding in this kind of effort, increasing the number of female students dramatically, would be unproblematically positive. Besides, as stated in Chapter 9, women were seen as an asset for the

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attracting qualified students and being hard and difficult. It might have been even more difficult to find acceptance for a model picked from, for example, any liberal arts education.

social climate at the institution, and enrichers of the narrowly technical curriculum.

However, the question is not that simple. What female students represent and what they require of their education are aspects which hitherto to at least a certain extent, have been negative for an engineering programme's reputation. Consequently, when seeing the world of Swedish universities of technology as a Bourdieuan field, it can be said that even if a fair percentage of female students is increasingly becoming to represent economic capital, this still has to be weighed against the fact that they do not represent symbolic capital, which is very important in the field.

Relating to different groups in the context

While the general attitude at the institute was said to be positive for recruiting women, there nevertheless were some groups which demanded extra consideration. There were both those referred to as the conservative old guard, and the male (and to certain extent the female) students. While the old guard could be left alone and be expected to die out with time, the opinions of the students had to be taken into consideration. Outside the immediate institutional context, the attitudes of the future employers were seen as very important.

The reformers stated that in general recruiting female students was looked upon positively among the faculty. Many of them also saw their departments as being basically gender-equal – even if there was also a number of female and some male reformers who did not[37]. However, this could also be an effect of the fact that in the prevailing societal climate it is practically impossible for a faculty member to say out loud that he is not for gender equality or for more women in engineering. Instead, they pay lip service to the official ideology, or even believe that they welcome women, while actually not having thought over their standpoint.

> There's no one there who will stand up, maybe there is, but as I said, they don't stand up and say that things are going wrong -- admitting women. On the other hand, it's very common to meet--" no, but we have a completely gender-neutral programme, there's nothing to stop women applying, they are very welcome"... even though it is very easy to find problems and attitudes and other

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[37] At one of the departments involved at LiTH a project of improving gender equality was going on at the time of the planning work.

> things that are different between men and women. So there is a sort of, what should I call, naive insensitivity to these problems, which I think is a lot of the reason why we have not been so successful. (1017L)

The official all-win opinion about gender equality is important in this context. Gender equality is not seen as a question of power, but as something that will benefit everybody, and thus something that every sensible person is for. In this kind of context which is basically seen as gender-equal, the lack of girls in engineering is a mystery. The general attitude to recruiting female students, especially at LiTH, seemed to be one of hopelessness - there have been efforts but the girls will just not come.

However, the generally positive attitude to gender equality or recruitment of women seems to prevail only as long as it can be a subsidiary to the all-win concept. Any measures which can be perceived as favouring women tend to raise more or less marked negative reactions, if not from everybody, then from some people who hitherto have been quiet about gender equality. This had come into the open at the department at LiTH which had tried to enhance gender equality among the faculty. When the benevolence for gender issues is strained by active measures, involving deviance from what is seen as normal, priorities are revealed, where the masculine environment is expected to remain basically unchanged.

The restrictions of the positive attitude to the recruitment of women showed clearly in the definite attitude referred to by the interviewees, and sometimes presented as their own, that the reforms should not go long as to scare away potential male applicants. The image of the programme should definitely not be so female as to repel men.

> You are so careful about the boys, like, you don't want to lose them. You want to have the girls as well, but you don't want to lose any boys... you don't want to make any really major changes, so that you risk alienating these boys instead. (0017L)

One group of opposers were expected to be the faculty members who are foreign to the idea of female engineers and especially to the idea of a need of more female engineers. In the interviews they were referred to as the old guard and not seen as a great problem, as they will retire in the future anyway.

A more important group were the students. Lewis (1993) reports a shift in the behaviour of the male students when the number of the female students increases, to become much more sexist. Not to get the student opinion against the changes was an important consideration. Some resistance from among the male students was experienced, though not directly concerning the recruitment of women, but rather the better facilities which the students on the new programme were supposed to get. The female students actually seemed to be more dubious than the male about the programme in itself and the image it was projecting.

The female students normally become socialised to the educational community Even if they engage in student politics, they do not advocate big changes in the educational programmes or in gender issues. (Kvande, 1984) Rather, they often oppose any efforts to promote the situation of female students, saying that female students should not be singled out in any way. As an example, the recruitment brochure for the LiTH programme, where the project leader mentioned that the programme was to attract both women and men was reported as having received some negative reactions among the present female students.

This can also be explained by Bourdieu & Passeron's (1977) statement that those who are subjected to symbolic violence are not aware of their own situation but have the choice of trying to attain the cultural capital offered or becoming outcasts (or getting out of the reach of the educational programme, which is possible on the level of higher education). Those who stay believe in the myth of equal opportunity, just like pupils do in schools, according to Bourdieu & Passeron.

Another group outside the institute that had to be considered were the future employers. Responding to the needs of the industry is important for universities of technology. Engineering education institutes do not simply send their students out to reality after completed studies to find their fortune, but are in close contact with engineering workplaces. There the reformers could expect to find support for their ideas, even when the institutional context seemed chilly. This belief was implanted by the project leader and strengthened from time to time by his referring to different kinds of evidence that the kind of engineers who would come out of this programme were just those whom the industry was looking for. Perhaps this programme would not educate those engineers who were the first and foremost in the frontlines of technical innovation, but it would educate employable engineers for tasks which were both increasing in numbers and gaining status. As we have seen in chapter 9, these tasks were also seen by many of the team members as suitable for women, which further supported the ideology of recruiting female students.

What did the money do?

Getting a large grant for curriculum transformation is something very exceptional in the context of a technical institute. In an environment where most often research is seen as the most prestigious activity, it gives legitimacy to the efforts.

Bourgeois & Nizet (1993) suggest that in an academic setting legitimisation in general is the most important form of power in implementing an innovation. At the same time most of the resources they take up as legitimising are difficult to use in the context of gender reforms in engineering education. Legitimising people in high positions inside or outside the institution are scarce, as are equality experts who have authority in the setting. Information on gender issues has difficulties in finding its way into the institution and being regarded as relevant. As to rules, institutional equality policies are often vague and are not seen to carry the same weight as several other regulations. Thus, the legitimising function of money comes to be of major importance.

Some features of the institutional context where the money was to operate have already stood out: common acceptance for recruiting women, but a reluctance to let it affect the normal running of affairs; a reputation based on different kinds of toughness and technological excellence; urgent need for pedagogical reform experienced by several individual teachers; lack of knowledge of gender issues and the consequent incomprehension of women's rejection of computer engineering; and a need to adapt to changing demands from the industry. The money could be used freely in this institutional context and there was no definition of how the success of the reform would be measured - even if the implicit expectation was that the number of women enrolling the first year's would be of importance.

Actually, the team members did not see very much of the money in use. Instead, the grant functioned as a kick-off for the project leader to sit down and use some time for envisioning a new educational programme on paper. The grant made it possible to create something no one in the organisation, except the project leader, had envisioned. It was not seen as a prerequisite for changes in computer engineering education, even if it certainly had accelerated the process. But putting women on the agenda at all could be attributed to the grant.

> **Do you think anything would have happened without the money?** Well, not this fast anyway… /the project leader / could have gone to the dean or the board and said: "I have this idea and this is what it looks like." And eventually could have got support… but I think it went much faster this way. **Would there have been any 'girl aspect' do you think?...** There I'm not so sure if /the project leader/ would have thought about girls so much… since we've been sitting here for years sighing about not being able to get girls to do technical studies and still haven't done anything… So I have a feeling that it wouldn't have been that which triggered it, but rather PBL instead. (0017L)

However, as we have seen, women on the agenda to a great degree stayed on the agenda but did not get as far as influencing the concrete plans for the new curriculum, and so, in the end, the grant from the Council legitimised the work on a radical pedagogical reform, which many at the institution itself would have been reluctant to finance.

> I mean simply trying to create a programme on a voluntary basis-- and I don't think it would have gone down too well with the board either. Now they knew that this was something that millions had been ploughed into. And you can't simply wave it away, but if a little delegation had come and said that they were thinking about a new programme… then I don't think it would have worked. So the money was probably important. (0001L)

The institutional leadership

In spite of the project leader being the leader of the computer engineering programme, the new programme was planned in parallel, with practically no connections with the ordinary programme. In a way the project leader was turning his back to the whole organisation of engineering education, wanting to create something totally new from scratch. However, the institutional leadership had to ensure themselves that the new programme would have the qualifications required to be called a master of engineering programme and that it was worth investing in.

Once the institutional leadership had signed the contract with the Council, the project leader and his team were left without special surveillance. The team did not, either, inform the rest of the institute very much about its work. What hearsay seeped out was more about the pedagogy than about recruiting women. The pedagogy aroused opinions for and against - nobody was against recruiting women.

> There are quite a few who are sceptical of PBL. PBL is actually, it has a more prominent place in the discussions that recruitment has. So it is discussed, and then there are many who are sceptical about whether this will really give us more girls.(0601L)

> I don't think that very much information emanates from the programme, there's still very little written about it all… many of the, so to speak, ordinary teachers, they wouldn't know so much about this… even if you're on the programme board, nothing very much has been presented there. There is no real financial plan, actually. I wouldn't be able to tell anyone today what the teaching is going to be like.(1917L)

The planning team had not really cared about how their work would be seen by the governing board of the institution. They were on a state grant and realising a project which had been viewed positively by state authorities. A new programme had started at LiTH with no discussion the previous autumn. It was somewhat of a shock when the governing board, after a year's work, sent to the group a list of questions and demanded information before they would decide whether to start the programme or not. For a few weeks the future of the programme seemed to be at risk. The team efficiently produced the documents required and a group selected by the project leader was invited to speak about the work in a hearing.

The list questions stated by the governing board even touched upon the ambition of recruiting female students. However, in the written answers which the group sent in this question was omitted. In the hearing the group was also asked why they thought this programme would attract women - and one of the answers given was the fact that several girls had called the persons responsible for information and had been interested in applying. The project leader also gave an explanation (of the kind he had presented to the planning group in the beginning) of how the new curriculum would answer to the needs of the female students. On that occasion he even said that some boys could be scared away by the image of the programme, but that it was acceptable. After the hearing one of the team members pointed out to the project leader that it would have been a good idea to attach a reference list on gender and technology in the papers sent to the board as the board seemed to have been interested in the issue. The project leader answered by saying that such a list did not exist.

The problem for the board did not seem to be the recruitment of women – this could perhaps be regarded as one of several efforts that had been made in that direction - but the radical pedagogical change. The whole idea of PBL had a fuzzy connotation in many engineering educators' ears. Recruiting women was looked at more favourably but the board was sceptical about the possibilities. The task of the project team was to convince the board that engineers could be educated by PBL.

> The thick pile he produced, the factual stuff, made a big difference. He was probably a little too vague in the beginning... /the project leader/ he wasn't clear enough. And they didn't know what PBL was. So it was an exercise in education. /The project leader/ explained how he thought. When he eventually got time to do it, it was straightened out. (1324L)

In the end the programme was accepted mainly because of the innovative pedagogy, subject integration in particular, and the enthusiasm of the group. At least, that was what the planning team thought.

It is possible that the interest of the governing board in gender enhanced gender talk in the following team meetings. The group for gender issues was set up in the next meeting and special measures for recruiting women were planned.

Thus, the grant from the Council was not quite enough to convince the university board that the programme would be something to invest in. The main problem was probably the lack of information from the planning team - it was difficult to know what the programme really was about. The hesitation of the university board concerned mainly the content and the pedagogy - one important underlying question seemed to be whether this programme really could be equivalent to other master of engineering programmes. But there was also a clear interest on the part of the board in the question of recruiting women. This interest seemed to be greater than the planning team had expected. But the planning team had been ignorant of this interest during the first year's planning and allowed themselves to concentrate on the pedagogical matters. By the time of the second round of interviews, six months after the hearing, the impact the new programme would make in the organisation could be seen as depending on how well it would manage in recruiting women:

> If there are going to be lots of girls, everyone is really going to come and look, how did this happen and what have you done, and what did you say, and what is PBL really, tell us. I definitely believe it. (0601L)

Ambivalence towards a feminine image

Because the team were creating a whole new educational programme, they were also responsible for creating its image. That is why the contradiction between the tough image of engineering programmes and the wish to recruit female students was particularly troublesome. In that respect there were actually two problems: to create an image which would attract both girls and boys - based on practically no knowledge of what really did attract girls - and the problem of making this image such that it was acceptable in the engineering field and did not drag down the reputation of the programme. Had the reform team been conscious of the institutional interest in recruiting women, this problem might have been easier but far from unimportant.

The question about what would attract female students was solved mainly by the female student representative of the group, to whom the others referred. The basic idea was that women are not interested in, or are scared away by, the image of computing. That was why the other aspects of the programme should be stressed. In concentrated form this can be viewed in the unofficial list of "forbidden and recommended words" written on the board at one of the team meetings (Sept 1994):

Recommended words	**Forbidden words**
society	engineer
care	computer
user	programming
communication	technology
organisation	specialist
collaboration	female perspective

This part of the problem was cleared quite easily. The question of how girls would react to the message that this programme was created particularly with girls in mind was trickier. The general opinion of the team (which was also the opinion of the student representative) came to be that women are not interested in anything specially created for women. Besides, that kind of image would scare away prospective male students. Thus, the gender aspect should be toned down as much as possible in the marketing of the programme.

> ...if you tell them that it is an engineering programme, but that it includes communication, and if you manage to get this across as ... with a bit of status and finesse, and don't talk to much about the fact that it is pure girls' programme, like, but more that this is a

> new programme, an interesting programme and a new method of working and those kinds of things. (0017S))

This image would also be the proper one in the institutional context. If the programme got a feminine image, it would be perceived as less serious by the colleagues and the authorities of the institute, it was believed. The same was seen to apply to future employers – while the qualifications in themselves would be desirable for them, they would not be appreciated if they came from a soft and feminine programme.

> **Who are you most afraid will see this as a programme for girls, is it the girls, the boys, the university or the labour market or-** The university and the labour market. Most of all the labour market, because if the labour market begin to see it as a programme for girls, then not many boys will apply, and not many girls either, for that matter, because they won't get jobs. So it is--, yes, the general attitude of society, like, rumours that circulate, that wouldn't be so good. It would be unfortunate if it became a programme for girls, I believe.....**that the labour market does not want to employ girls?** Yes, well, they like girls who have a proper male education. Unfortunately, it can be that way, that they think this is easier in some way, so as to attract girls, or easier because there are more social sciences or so, and that can be dangerous. (0320L)

It soon became evident that the interest of the media in the programme was based on the gender aspect, so it could not be totally obscured. The team was not totally happy about the media coverage, even if the pedagogical reform often got good space in the text. However, in the institution itself the gender aspect was effectively suppressed.

The ambivalence as to the image of the programme was expressed very clearly in the discussions about how it should be abbreviated.

All Swedish master of engineering programmes have an abbreviation, which is used more commonly than the whole name of the programme. The name used in the grant proposal was Q. Originally, it could be seen as just a letter which was not used by any other programme yet, but soon it became perceived by the team as something referring to an old spelling of the Swedish word denoting woman, "quinna". This abbreviation was used for several months, even if there might already have been doubts as to the appropriateness of the name. However, the explanation internally was that Q was not necessarily referring to women, but to quality.

That was also the explanation given by the project leader to the listeners at one of the departments involved, when he had an information session about the programme. However, his listeners did not accept this explanation but continued to discuss the abbreviation and it became clear that in their minds the programme had a connection to women - a connection which they did not regard as positive. In the next project meeting the project leader initiated the discussion about the abbreviation and the group decided to adopt the abbreviation IT, which had a strong technical connotation. However, discussions about the abbreviation recurred regularly during several months. The following discussion was conducted several months after the first one, initiated by an argument by one of the team members that IT was getting a very masculine image in the media.

> M1: The discussion ... where the opposition to Q was quite strong, that was just that people associated it with women , and then they say that it will be a -, can be viewed as being tailored for women. And it will be an, almost quota-based. Not quota-based, but perceived that way. Apply here, girls, but not boys. A bit like that. That was my experience of the discussion at Department X[38].
>
> ...
>
> W1: But I don't think that the name Q programme will scare off the boys, I don't think so. Among the students it's called the Q-programme and, like, they all think that's OK .
>
> ...
>
> M2: I was thinking quite the opposite to W1. I think that Q, the association with a programme for women, I think that it can make a difference for secondary school students... We are demanding the same courage as when a boy starts to study nursing. I think the woman bit will dominate.
>
> W2: I simply thought that if we call it the Q programme it might be easier to recruit women, in which case then we have to make an effort to recruit men. If we call it IT then I think we will have to make an effort to recruit women, because then the men will come, definitely. On the other hand it can be more difficult to get girls to come... If it's called the Q programme then perhaps I dare to apply because of the name. But if it's called Information Technology and boys and computers and, then it will be the usual thing. (Sept, 1994)

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[38] Interestingly, the term IT was quite unknown to the general public when the work was started, winter 1993-1994. However, a year after, when most discussions were taking place, it had become a keyword in the media and got a technical and masculine connotation. During the last few years it might have lost some of this connotation, as it is regarded in the media as synonymous with Internet - which is used increasingly by both women and men.

The issue was never decided on in the team. When the start of the programme drew nearer and it became necessary to use an abbreviation in the official documents, the programme was abbreviated IT.

The question of the abbreviation was symbolic as to the identity of the LiTH programme. How much should the ambition to create a gender-balanced programme weigh in relation to creating an excellent engineering programme with a good reputation? There was a possibility of directing the programme directly to women, with all the risks that were perceived as to recruitment - of both boys and girls - and, not least, the risk to the reputation of the programme internally. There was also a possibility of directing it to clever students, whether they were girls or boys. in the hope of getting institutional acclaim. The discussions on the name clearly showed an ambivalence between these two positions - and the resulting abbreviation was well in accordance with the general stand taken by the team.

The Chalmers context

The institutional context at Chalmers was very different from that at LiTH. While the institutional leadership was practically never talked of in the LiTH interviews, almost all Chalmers interviewees referred to the support of the institutional authorities. Both the pedagogical renewal and the recruitment of female students were said to be the concern of the central authorities:

> I think that the rector and those at the research and educational administration, that they are positively inclined and do what they can, so to speak, to help, if they know that they can help. **What do you think they experience as positive, the fact that something is happening or the recruitment of girls or what?** Partly, that a programme is being reviewed, that it's not being allowed to stagnate, and partly that we are working to get more girls, because as I said, numbers have gone down, whether that is personal conviction or because the parliament and government have sent out signals that more girls are needed. (0514C)

This concern was seen as tied to the new financing system of higher education, where the universities are funded partly in relation to the number of students who go through the programmes and get their degrees.

> Then of course it is a question of the fact that the whole system of higher education in Sweden is not based on, as it was previously, that you got money for every group you admitted, it's a question of their performance also. And in that case, students must enjoy their education... I suppose we are a sort of pilot project, somewhere I suppose, for this. (1416C)

An important person in the Chalmers context was the female vice-president of the institution, who had requested the project leader to apply for the grant in the first place. She continuously followed the reform work and was identified by some of the interviewees as the person who kept gender issues on the agenda. But it was not only her the reformers were referring to. In general the reform was perceived to be of the kind the institutional leadership had been asking for and promoting. This seemed to be a considerable motivating factor.

The reasons for the interest of the institutional authorities may be that the institutional leadership had undergone changes during the previous years. The female vice-president's personal influence on other people in leadership positions was also deemed to be considerable by the reformers. A further contributing factor might be that the overall atmosphere for recruiting women seemed to be somewhat different from the hopelessness at LiTH. Even if both universities had taken special measures to recruit women, the tradition was stronger at LiTH - and LiTH had also an experience of such measures being relatively unfruitful, especially in regard to computer science. Some of the activities introduced by the Chalmers reformers, such as hands-on weekends, had been in operation for several years at LiTH. At Chalmers the task of recruiting women into computer engineering was perhaps deemed to be more possible to realise than at LiTH.[39]

And a reform of the computer engineering programme would have been necessary anyway. It was looked forward to both among the faculty and among the institutional authorities, after the new programme leader (who became the project leader) had been appointed. The national evaluation (Quality Review Committee, 1994) had to some extent confirmed the picture of a stagnant programme in need of changes. The initiative of the Council fitted well into the plans. The question was to gear the reform towards recruiting more women.

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[39] As to the future, after one year's operation the LiTH team were going to cut down all special recruitment activities, because they were not regarded as worth the effort, while the Chalmers team were convinced of their effect and were going to continue.

> **Do you think there would have been anything if you hadn't been given the money?**...We might have done the same thing but not at the same speed, not with the same banner headlines and not with the same primary motivation that this is motivated by our wanting to get more women to apply. Instead, perhaps other reasons would have weighed more heavily. But we would have, I imagine, we would have done the same things. **But a bit more slowly?** Yes, because we all have so much to do it could more easily have petered out. Whereas now we have a project, we really have to do this... I think that /the council/ can confirm that the money has started something big in any case. So we have to hope that we also reach the goals that have been set up.(Project leader, Chalmers)

At Chalmers the grant both authorised and made it financially possible for the project leader to try a much larger reform than could have been done otherwise. It also brought gender issues onto the agenda - even if only about half of the interviewees believed that the grant actually had affected the objectives of the reform on this aspect. (The others shared the conception of the project leader - that the reforms would have been the same, but not based on the gender question.)

There was no question of the reform resulting in anything else than a continuation of the present master of engineering programme. Thus the problems of the image and gender coding of the programme were not relevant in the same way as they were at LiTH. But even at Chalmers the traditions could be experienced as restricting:

> Like you want to retain the cachet of being a good Chalmers education in some way... this is after all a programme which is regarded as having a fine status... and so you couldn't make too many changes. (0019C)

Thus, the problem of how to compromise between the need to keep up. the reputation and the alleged needs and preferences of female students did exist, and even if the context was perceived as basically positive to the reform, this conflict could be problematic even for an individual reformer interested in recruiting women. But the problems were not of the same magnitude as at LiTH, and the opinions as to the desired balance between an image of a gender inclusive programme and the image of a reputable engineering programme were more divided at Chalmers. There many of the reformers believed that the criteria for the reputation of an engineering programme actually had changed or were in the process of changing, not least because the demands of computer industry were changing, and that their programme would be appreciated according to the new criteria. Backed up by the central authorities of the institution they believed to a greater extent that what they were doing would be appreciated in the context, both with respect to recruiting women and to pedagogical renewal.

> But then I think it's like this that Chalmers has a very good reputation, you can't get away from that. It is one of those universities in the whole world that has developed a good reputation. But you can't rest on a reputation. And I think it's time now for Chalmers also to venture out and become a part of the networks that exist in Europe and follow current trends. And this is part of it. And most of all it's because we want to attract more girls quite simply, it's a thing like that, a quantitative thing. They want to measure things. But at the same time I think it's because a lot has arisen with regard to-- there is a forum for pedagogical development and those trends that exist within pedagogics, the project follows them. It's one of those things and the Chalmers board supports it. (1416C)

The different positions of the two programmes on the institutional maps can be symbolised by the premises allocated. While the first LiTH students were housed in improvised premises, found by one of the team members, and forced to move after some months' studies, a special building was renovated for the Chalmers students to facilitate the new working methods. This succeeded due to the interest of the vice-president. Except for being important for the realisation of the plans, the building, where it stood, had a significant symbolic value.

As to groups on the programme level, there was naturally the "old guard" - and some of them would probably have to be used as teachers on the new programme. But, like at LiTH, they were not experienced as a great problem compared with a fraction of the male students, who were seen as perhaps the most problematic group in the efforts to introducing gender equality. They clearly expressed their dissatisfaction if they perceived that women were favoured.

> I think it's very important that you don't single out girls as a group....the students here on the computer engineering programme have been adamant about the danger of singling out a group...so that there are priorities or quotas or things like that. (1416C)

182

Jealousy was given as one explanation for the male students' sometimes negative attitudes.

> You get the odd side remark sometimes, I think... very disparaging comments, "that won't be any good", "hell, it'll be chaotic", like why should girls have such a good situation, a lot of jealousy. (0201C)

Even when the male students say that female students are welcome, they also point out that this is the case only if they have the same conditions as the men. Only a few of them were directly involved in the reform work, and among the rest there were suspicious voices opposing any differential treatment. It seemed that many of the reformers had difficulties in arguing in favour of women – that they themselves were ambivalent as to the differential treatment of the sexes.

> Most think that there are too few girls for a number of reasons. But at the same time there are those who think that some of the things being done now are a little ridiculous. For example we have planned a kind of girls' room in the new building we're getting. Where girls can go and rest if they aren't well or hang up their clothes and change if they 're going to a party or so... I suppose a typical reaction was when someone saw the drawings for the first time and it said 'girls' room' on a sign over the room, they took a pen and wrote 'boys' room' over the computer room. A bit oversensitive and unnecessary in some way. It's probably also a reaction that some girls feel but at the same time I know that there are a number of girls that want the room. And that particular space wasn't much use for anything else that would be that much better, so I think it's worth the expense. (1712C)

The solution for the reformers was to tread carefully, and take the male students' opinions into consideration. In contrast to the observations at LiTH, there did not seem to be any resistance to taking measures to benefit women from the part of the female students. (It is possible that the pro-reform female students engaged in the process silenced - or obscured - their female peers.)

While the LiTH team could use the argument of industry needing a different kind of engineer as a justification for something that could be looked at suspiciously in the academic context, for the Chalmers reformers the interest from industry was one of the factors in the positive interest of the institutional authorities.

> I think that Chalmers has a good reputation outwardly and I think you have to work to maintain it and I think that this is a way to do

> it... Above all you want a good reputation among people in industry, and business life, then it's really important that we, that our product, namely the engineer is a good engineer. You can't just presume that since it has always been good before, it will be good now too, rather you have to work to make it good in the future too. And I think they have noticed that at the top in Chalmers, too. (0514C)

The problems resulting from the ambivalence as to the image given to potential applicants, experienced by the LiTH team, did not appear at Chalmers. To start with, the situation was different. The "guaranteed" student body of the computer engineering programme - young men from the region on their way to the local computer industry - would probably continue to come, as long as the reforms did not change the programme altogether. There was hardly any risk of changing the image of the programme to become feminine overnight. The boys who might be scared away by the changes which were made, were seen as probably being of the hacker type and not much longed-for by the reformers. And as it was clear that the institutional leadership was positive, and the computer industry was supposed to be positive, too, the situation was quite secure.

The attitude to the media coverage of the programme mirrors this security. At the outset there was an article in the local press, describing Chalmers as a masculine bastion, which the reform would try to change, and initiating a short debate in the paper about the male dominance at Chalmers. The reaction to these articles, stressing the gender aspect of the reform, was different from that at LiTH. Even if the articles were thought to be a bit too aggressive, the positive effects of getting publicity were seen as more important.

But the Chalmers reformers did not, either, want to stress the gender aspect too much when recruiting new students, men and women, to the programme. The most important content in the information would be telling about the role of technology in society, and the reform ideas of project work and curriculum changes. This would, hopefully, attract women as well as men. So even at Chalmers the image was to be perpetuated as a good engineering programme, answering to the needs of both the students, computer industry and the society, rather than an engineering programme which had been created with female students in mind.

> We don't do stupid things just to make it good for the girls (1401C)

Summary of chapter eleven

This chapter shows how the reforms came into conflict with the cultural context of engineering education. Both the pedagogical aspects, which were the primary interest of the reformers, and a gender inclusive education were difficult to implement in a context where status and reputation, based on toughness and technological excellence, are important. While pedagogical changes are welcome, they soon collide with institutional ramifications and the unexpressed doxa which regulate what "real" engineering education is like. As soon as a programme wants to be called a master's programme in engineering, there are basic values and traditions which start to apply. It is possible that they are changing, and that is what the reformers could hope for - but at the same time the reformers themselves were carriers of these values and traditions.

The attitude to recruiting women was positive among the colleagues of the reformers. Women are welcome in the environment and welcome even to enrich the curriculum, but only as long as they do not try to change the basic values and numerous traditions it is built on - and a gender inclusive curriculum is bound to do exactly that. In the institutional context it seems easier to stretch the limits for the acceptable with the motivation that the education will be better than by saying that it is because of the wish to recruit more women - which is one more reason for working with pedagogy rather than gender.

The basic idea in the context is to treat everybody the same way. Even a vague suggestion of differential treatment of men and women seems to arouse protests. Only reforms which profit both men and women can be implemented in this kind of climate. The students in particular protest against any privileges that might be given to a special group, such as women.

The reformers could expect the remedy to come, by and by, from the outside: the computer industry was said to be interested in both the new pedagogy and in recruiting more women. A certain image of this agent on the outside, more foreign than the colleagues and students met in daily interactions, could be. and was at least at LiTH, used for encouragement in the sometimes sceptical environment. Some help from this adjoining field could further the questioning of some of the doxa in the field of engineering education. As to commenting on the practices in engineering education, the industry may be seen as a more influential actor than educational authorities like the Council.

But primarily it was still the grant, the money, which made it possible to assert ideas foreign to the context - both pedagogical reform and gender. It was a clear indication that the state authorities regarded both aspects as very important. However, the autonomy of the educational system (Bourdieu & Passeron, 1977) enabled the universities to transform the money to the kind of reforms they wanted. At LiTH it was mainly used for legitimising the radical pedagogy, while Chalmers, rather than introducing very radical innovations, forced the pace and widened the extent of the reform which would have been made anyway. The possibility of legitimising special measures for women was used only to some extent at Chalmers and hardly at all at LiTH.

The working contexts of the two teams were very different. The LiTH team worked quite isolated and was questioned in its institutional context. They were creating something that, in time, would be implanted in the context and set side by side with other engineering programmes. In this comparison the new programme should come up to the mark. Its image was very important and one of the risks, connected to its origins, would be that it was regarded as feminine. The LiTH team took great care so that this would not happen - and were confronted with the dilemma of creating a gender-inclusive programme which should not look gender inclusive, or attracting girls to a new gender-inclusive programme without saying that it was gender-inclusive.

In contrast the Chalmers team had good institutional support, which was important for the team. Pedagogical change and the recruitment of women were experienced as issues which had high priority among the institutional leaders. The female vice-president of the institution was responsible for much of the support for the reform and also was an important person for keeping gender issues on the agenda. As the Chalmers reform ran no risk of creating something labelled feminine, and as they could be certain of the support for efforts for recruiting women, their task of integrating gender in the planning work was much easier than at LiTH.

Thus, the masculine environment of a university of technology makes talking about women and planning for women something special, an unknown terrain. Planning explicitly for a gender reform implies trespassing on conscious and unconscious traditions, maybe questioning the doxa (of which the gender contract is a part) and thus arousing resistance. Therefore, some caution is advocated. Having a large state grant behind one's back gives a status which makes some violations possible, but the institutional environment is still decisive for the result.

12. Some features of the programmes as planned

In the previous chapters the internal and external problems and dilemmas of the reform teams were described. Those chapters give an account of obstacles which hinder a profound change when planning a gender-inclusive curriculum and give an explanation of why all the original ambitions, at least at LiTH, were not realised. This chapter describes the results of the planning teams' work, the way the programmes looked at the time of the second round of interviews, five to six months before their start. Both conceptions of female students, and the wishes and ambitions of the team members as well as the restrictions imposed on them by themselves and by the institutional context can be traced in the appearance of the programmes at the end phase of the planning stage. This chapter is also a forerunner to the last chapter, where the realisation of the programmes by first-year students and their teachers is examined.

Process data from LiTH, i.e. observations, are important in connecting certain features of the programme to the instances where choices had been made or showing them as results of interaction patterns in the team. However, interview data are also important in expressing the individual reformers' opinions of their team product. As to the first aspect, the data from Chalmers are practically nonexistent, while there are some descriptions of the programme and some opinions of it in the interviews.

Female-friendliness at LiTH

The restrictions in the inner and outer frame clearly left their mark on the appearance of the LiTH programme. Most notably, during the planning process the programme's special features with respect to the content became less prominent. The main restriction was, naturally, prohibiting the programme to be prolonged by one term, which lead to cuts in the planned content. The technological content could not be cut very much, only compressed, if the programme should equal the ordinary computer engineering programme. So the curriculum became very full and the social sciences and humanities content was, even if larger than in engineering programmes in general, not of the dimension which was envisioned in the beginning. However, problem-based learning was said to offer women the possibility throughout their studies of focusing more on those aspects of the subject matter they were interested in.

Something that was regarded as important was not to give the men who had previous experience in programming a chance to show off. Computing would start with something that was not a common experience for teenager hackers.

> We are going to make sure that at the start, if there are male hackers in the group that they won't get a headstart. It's a matter of sitting on them immediately. (1311L)

The reformers had to consider student groups with both men and women (in which the women were expected to be a minority), where all students would get equal and similar treatment. This restricted the reforms to those which would be accepted without too much trouble by the male students, too. For example, teaching about communicative patterns (and gender interaction) was postponed until later in the programme, as experiences from the present male students indicated that there was no interest for that kind of issue early in the programme.

The social environment, the interaction among students and between students and teachers was seen as a very important element in the well-being of female students. However, not many of the reformers envisioned particular problems being caused by women's minority position. To start with, as expressed in chapter 9, they did not seem to regard these problems as important for the students at present, and besides, even if the interviewees did not believe in the 50-50 goal, the programme was expected to attract many female students, which would make problems with a minority position even more irrelevant. And further, there did not seem to be much that could be planned for in that respect. The discussions about the possible problems of the female students in the social interaction concentrated on *nollning*.

Nollning was the one single event and tradition which was regarded as being experienced negatively by women, at the same time as it was seen to serve important goals in making the new students acquainted with each other and with the social life at the institute. It was discussed whether there should be efforts to find female students for the nollning of the students of the new programme, but finally those students responsible for the nollning were contacted and reminded to consider the fact that there would probably be many women in the group.

The relationships between teachers and students were not discussed with regard to gender, either in the interviews or in the team meetings. In general it was seen as positive that the new teaching methods would give the female students a closer contact with teachers. If there was any insecurity on the part of the male teachers about how to handle all these relationships to the satisfaction of female students, it was not voiced.

The issue of male students possibly dominating in the groups was discussed in the team, but delegated to the group tutors to take care of. The principle was to spread the women in all the groups, even if they would be a minority, because all the groups should have the advantage of women's different perspectives. The original idea was that the group tutors should get some training in gender relations. The basic training required to become a group tutor was a two-day PBL course, simulating different group situations. The project leader had asked for gender issues to be considered particularly, but learnt after the course that it had not come to very much.

> I spoke to the /course leader for tutor training/ and she asked me if there was anything she should take up, and she was thinking about something that was particular to the institute of technology. And I said no, but there is the matter of gender roles, we'd like to include that. And then she was a bit surprised. And then I asked those who were there and, no, it hadn't come up to any great extent. And that's a pity. It means that this is one more step for us to take. The tutors must be aware of these gender role issues. (Project leader, LiTH)

In the interviews the reformers were asked to evaluate the gender aspect in their programmes by answering the question: What is good about the programme for the female students?

A common answer was the number of women. If the programme managed to recruit a sizeable number of female students, they would feel at home.

> I don't know if I can say directly that it will be so much more girl-friendly. But I think that if there are 50% girls, they will like it better. And then hopefully they will enjoy working in a group as well, but that depends a bit, some girls like it and some don't. (0320L)

Problem-based learning with group work and a holistic view of technology were also believed to be beneficial for female students.

A programme for ordinary women?

As we have seen in chapter 9, the reformers tended to regard women who are in computer engineering now as special and few. To increase the recruitment, maybe they should try to attract the other "ordinary" kind of women?

However, there was an effort to widen the recruitment base towards "ordinary" women by admitting even students from the social sciences programme in secondary school. These students were to enrich the programme with their special background - and they were envisioned as women in the discussions. The decision to admit these students was the project leader's, and was very controversial in the institutional context. This far it had never been questioned that the only relevant background for engineering students would be that from the sciences programme in secondary school.

The original idea of mixing these students with the ordinary students from the science programme on an equal basis gave the group a lot of headaches. What to expect of them, especially with regard to secondary school mathematics, was discussed, as none of the team really knew what mathematics the social science students had studied. Was it really possible to make engineers out of them in the same time limits as science students? They would need compensatory instruction on subjects which they had not had in secondary school. An idea that perhaps the other students could get some social science or philosophy during that time was presented in the very beginning.

The need to enrich the programme with these students and the doubts about whether it would really be possible, as well as the negative attitude of the institutional authorities were finally reconciled in the decision to create a quota of five students of this kind on the programme. This could be seen as an experiment, rather than a commitment. These students were to be taken in by a special admittance procedure and spread out in the different groups the students would be working in.

While the possibility for these five students to apply and the importance of their enriching the programme was emphasised on some occasions by the project leader, in practice they became more and more marginalized in the curricular reform.

> We spoke about the /social sciences programme/ and so on, that we would get girls from there and there was a load of good ideas.... but then I think that this, PBL and the engineering label have taken over, like, so it has almost, it has been very dominant for quite a long time. (0001L)

After some research into the area it was decided that the social science students needed compensatory mathematics. Luckily, a summer course with compensatory mathematics had been started the previous year. It was decided that, after being accepted by an interview procedure, to get final admission into the programme, the social science students had to complete this course.

Quite soon the idea of social sciences for the other students vanished from the discussions. The mathematics problem being solved, the problem of physics was left. These students would not have had physics in secondary school. During some time there was an idea of giving them complementary physics during the first term, but later it was dropped. There was no space for extras in the curriculum, so a kind of hope appeared that these students would be so clever that they would manage the physics anyway, especially when they had the student group to help them.

In the end these students were given no formal advantage for their special background. Instead, they were expected to work even harder than the other students, at least in the beginning of the programme, to be able to learn the physics content of ordinary computer engineering education without the previous background of secondary school physics. While this issue generally did not seem to trouble the reformers, one of them expressed the inequality in their situation and recognised the basic assumption that only a traditional natural sciences background is of any value in engineering education.

> Because that was also something I was in favour of, because it would be rather good, if we take a few of those social sciences people, that's sure to be a good start...And the part I have been sceptical of is that it will be much tougher on them. They shouldn't need to be better at everything. Show off and, we have to presume that they have actually learned something too, not think the whole time that technologists and those who have studied natural science at secondary school are the only ones who know anything and that we have to educate all the rest. (1621L)

What was to be the admission criteria for these students? Of course a good grade in mathematics and good overall grade. But from that group they were to be selected on the basis of an essay and an interview, where their motivation as well as their communication and social skills would be evaluated. The rest of the students, those with natural science background, would be admitted solely on the basis of their secondary school grades. Thus, the social sciences group could be expected to be even more social and communicative and more different from the natural sciences students than their secondary school background would suggest. These students were also to be spread out, one in each tutorial group.

The issue of the social sciences students is interesting, because it is an obvious transgression of the rules and traditions of engineering education. The effort was to introduce something different, students with another outlook. However, during the planning work it became more and more evident that there was no space for this difference. More and more these students were expected to adapt to the general plans and the deficiencies and resources brought about by their special background were not allowed to change the general curriculum of the new programme.

Apart from the question of social science students there are many indicators that instead of widening the efforts to interest "ordinary" girls for computer engineering education, the team basically was out to recruit more girls of the kind they already had.

> But it is so hard to say, I don't really know which girls are coming here. Because I don't think you can take the typical girls, or whatever you call them, the ones who sit and-- who do arts and, well, as I call it, fuss about, giggling, and all they can think of is boys and make-up and the like. I don't think, like, that they will want to come here... But then there are others that are, well, a bit more masculine, I suppose you cannot really say so, but like it's not the same type. (0320L)

Regardless of whether women who go into computer engineering are actually different from ordinary women, "special", the image of their being so, combined with the bewilderment in recruiting the "non-special" women indicates more of the implicit restrictions imposed on the team members. There would be risks if they got a female student population which would be very different from the present one. On a deeper level it touches the idea of computer technology as masculine, as something which ordinary women cannot be competent in. Thus, to go on recruiting the special women, but to increase their numbers seems to be the safest way to reach the goals of the reform work even if this means that women will always be a minority and that they will not threaten the masculine image of computer engineering or the status of the computer engineering programme.

Female-friendliness at Chalmers

The ideas behind the outlook of the Chalmers reform were expressed in the interviews, in connection with questions about the history of the programme.

We have seen that creating a wholly new study programme posed certain problems for the LiTH team, especially as to the image of the programme. As the Chalmers team could expect a continuing recruitment mainly along the accustomed patterns, other problems became relevant. The women would be a minority on the programme, and the opinions of the male students had to be taken into account more seriously than at LiTH, where the male majority was supposed to be smaller, and even these men could be expected to be favourable to change and to female students, having applied for such a programme. Thus, the principle of treating everybody the same, supported by many male students, was perhaps even more important to adhere to than at LiTH. In this more "ordinary" context special measures towards female students could be interpreted as their being inferior in some way. Stressing the satisfying of students' individual needs was a solution adopted at Chalmers.

> Sometimes perhaps you hear from female students that " we don't want to be considered different", for example. But we don't do that either, I think, but it's more a question of our, in treating boys and girls the same, or as equals I suppose I should say, we don't forget that they are different in some way. That's what it's all about, but we should treat them all as equals anyway. (1107C)

Emphasising the importance of the individual coincided with the need to loosen up the rigid content structure which many students had been complaining about. The amount of electives was increased considerably, to give both male and female students the possibility to specialise. After the reform it was, for example, a possible to include up to 23% elective courses - even non-technical - in the degree. To the traditionally masculine education, women could add their interests and men could add theirs - that is, women could choose special treatment themselves and keep to one side of a gender division if they wanted to. One way to take female students' needs into consideration, without arousing cries of differential treatment, would be even at Chalmers finding a way to prevent the male students initially from showing off with their assumedly greater computer expertise.

At Chalmers the problem of what kind of women to recruit, "ordinary" or "special" was expressed more clearly than at LiTH.

There existed an opinion that the recruitment base should be widened to a type of female students who had not dared to enrol in computer engineering before.

> I think it is this type of girls who come to Chalmers in any case, but it isn't those girls we want to attract now. Instead we want to attract those girls who don't think that Chalmers is the right milieu for them. They are the ones we want to attract. (0505C)

Instead of special targeting, such as the social science students at LiTH, there was rather a hope that the appearance of the programme had now become more appealing, and that the message about it being so would reach more girls than before. Only an ordinary natural sciences background from secondary school was accepted - to get a greater number of those girls would be enough, instead of the very few who came now. Even among the Chalmers reformers trying to attract girls who lacked an interest in the area was warned against.

However, even if there existed the idea of recruiting women who would not choose a tough education in a tough context, in the end not very much was done about the masculine dominance of the daily social life. At Chalmers the reformers had talked more about the chilly climate of the institution than at LiTH, but they did not speak of any special measures to change it. Thus, even if the social environment was described as problematic, the female students were still basically expected to adapt to it, with the exception of the visible and more extreme form of rudeness in nollning.

The expectation or hope that the female students would manage their interactions with the masculine environment was also visible in the attitude to group work. It was to be an important study method also at Chalmers, acclaimed by most of the reformers, in spite of the fact that several of the female reformers also took up the drawbacks of men dominating in the groups. The need to monitor the group process itself to ensure gender equality was not stressed in the plans.

> I think that some girls can be a little worried because they feel that, damn, am I supposed to be a mother again. I did that in the group work we did in secondary school. That criticism has been put forward, it has become visible, so I don't think that there is any risk that it will be like that, instead it will be followed up a lot and each of them will be examined. Then, of course, I don't think that group work per se is going to be particularly good for girls. It's more the fact that they see a goal, I suppose. (0504C)

The teachers did not receive any special preparation for the special requirements, for example being aware of gender and group dynamics, for the new kind of teaching they were supposed to conduct.

What then, in the minds of the reformers, could be regarded as gender-inclusive when they looked at the programme as it was planned? The answers were hesitant. One could not really know until the women were there and evaluated the programme themselves. One could hope that taking in the societal aspects of technology in the subject content and working in groups would be appreciated. Just making better education would make it better for women, too. But even if the Chalmers reformers were unsure, it seemed that while the sheer number of women, i.e. attracting them, was a measure of success at LiTH, Chalmers was more bent on creating a programme that would respond to female students' preferences, once they had come to the institute.

Summary of chapter 12

A female student entering one of the programmes would meet a predominantly masculine curriculum, with some accommodation made for an increased social sciences content. At Chalmers she would have the chance to choose among several non-technical courses. At LiTH there would be less choice, but she would be free to find the societal connections of the technical problems herself and assert them in her study group.

The female student might feel that the teachers and her fellow students had tried to make the very first weeks of the study welcoming but that she would then be expected to adapt to the masculine environment or cope with it in some way. Hopefully she would have several female peers on the programme. However, at Chalmers they would still be few in comparison with the men. And in any case, the students she would meet outside her own programme would be predominantly male. She could not count on much free time to establish relationships with people outside the institute.

She would work in a group a great deal of her time. As to the group interaction, neither her fellow students or the group tutors had been made aware of the problematics which could arise. She could have the advantage of a female teacher more often than students at a technical institute in general.

If she were one of the "outsiders", the one with a social sciences background at LiTH, she would find that the knowledge areas which she carried with her were not on the curriculum, and that she was expected to manage a preparation in physics, which the others had from secondary school, on her own.

The programmes wanted to deviate somewhat from the normal habitus formation process in engineering education, and create another kind of engineers, with different patterns of thinking and acting (for example in teamwork contexts). They had to invent new processes to produce new kinds of students. Both programmes started with an innovative element: a course with the expressed aim of learning group work. At the same time both programmes also complied with the strong traditions of engineering education, most visibly the nollning, which is also an introduction to the process of forming an engineering habitus. The students should both adapt to the requirements of their own programme and to the traditional requirements of engineering education. However, these two would probably not come into conflict, as the appearance of the programmes themselves was a result of several compromises, between the team members, and between them and the institutional possibilities and practices. There were several unconscious considerations.

Without the reformers being aware of it, they had already made several choices not to really break with male patterns and traditions in favour of female ones. The needs that female students were assumed to have were accepted primarily in addition to traditional and male students' preferences. The reform teams' expressed ambition to create gender-equal education meant supplementing the education with something additional (female values), rather than profoundly changing the technological content. The common frame of reference and everybody's adaptation to the prevailing conditions certainly smoothed the planning processes. Perhaps it even was necessary for the processes to result in concrete reforms.

13. The programmes as they turned out

The programmes were still in the process of being designed after they had been operating for one study year. But some first indicators of their success and of the tenability of the ideas of the planners could be collected even at this stage.

This chapter is based on interviews with teachers who had directly interacted with the students during the year. Some of them were also interviewed as planners, and some were not. They spoke about their work and how it was affected by the reform, and how the female students were doing on the programme. The female students were not their main concern, instead there were other groups that had turned out to be problematic. The chapter concludes with a glance at the institutional situation of the programmes, now that they were actually operating.

Even if this account is based on the interviews of several teachers both at LiTH and at Chalmers, the interviews with two teachers at LiTH and three at Chalmers are given somewhat more weight than the others[40]. One of these teachers at either site had been involved in the planning phase. These five teachers, all female, often commented on the phenomena recounted even by other interviewees from another, more critical perspective. A majority of them had, somewhere in their background, some social sciences education, which in part may explain their different perspective. Naturally, there is a risk that I have been carried away by their interpretation of what had been going on during the year. However, when weighing the risk of relying basically on the positive, unproblematic accounts against giving an emphasis to these more critical accounts, I considered the critical perspective to give a more enlightening picture of what happened.

There are no data from the students. Thus, what the teachers say about students and their situation is not contrasted to what the students think of these matters. If this chapter were an evaluation of the programmes, this would be a severe fault. However, this chapter is not an evaluation of the programmes in themselves but a description of how teachers in presumably gender-inclusive programmes in their daily practices relate to gender issues, female students and the idea of gender-inclusive education, and how they believe that what they are doing is viewed in their institutional environment.

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[40] In practice, this meant that while normally a statement should have been made by at least three persons among those interviewed to find its way into this report, in this case it was enough for two "dissidents" to point out something for me to record it here.

Basic data

At LiTH many female students applied for the programme. It started with 35 students, 16 of which were women. Five of the students, four women and one man, had a social sciences background from secondary school. In general, the teachers at LiTH talked about the student body on the new programme as being of a different kind than ordinary computer engineering students. The presentation of the programme in the recruitment brochures had been a bit vague. Problem-based learning was explained and the ambition of recruiting female students was mentioned. It was also stressed that there would be social sciences content integrated with the studies. However, the exact proportions between mathematics, technical subjects and social sciences subjects had not been stated. Some of the teachers stated that many of the female students misinterpreted the information and were shocked when, upon arrival, they realised that the major part of the education would be engineering subjects. At the time of the interviews - when approximately one month of the first year was left - quite a few of both the male and especially the female students had considered dropping out of the programme, and some of the teachers expressed great concern about this.

Is the programme gender-inclusive?

The interviewees were asked to evaluate the programme by saying what made it gender-inclusive. Some of the teachers said that the proportion of women makes women visible and forces the teachers to consider them in their teaching. But none of the teachers could tell more exactly in what way they adapted their teaching to the female students. More commonly they turned to talking about students as individuals.

> It doesn't really happen like that. It's individuals that you're trying to help forward. And so some girls, and naturally I suppose there is something that's gender-related in what just they do, but it's not something that happens consciously on my part, because I haven't seen any obvious problems. (0101L)

Only one of the teachers interviewed told me about consciously creating a learning problem which would be attractive for both women and men.

Gender was not seen as a relevant aspect in teaching. Instead, gender was seen as relevant in the social interaction, both between students and between students and teachers. The view of the knowledge mediation aspect of the education as ungendered had not been challenged in the reform process. In the first interviews with the reform group and then throughout the planning process, discussions about male and female students were mainly related to the social environment in the programme. Even when the teachers were talking about PBL this division was discernible. The social aspect of PBL, working in groups, was seen as gender-inclusive, while the actual work of learning might not be:

> But I don't know if PBL is typically female-friendly, both yes and no. I think there is great security in sitting in a group and working that can appeal to girls... content-wise it's a traditional engineering programme, there's not much more of anything else than there is in the other programmes. So really it's the computer engineering programme, I think, but with a different way of studying. And the question is whether just this way of studying is more female-friendly. (0601L)

The social aspects of group work were mentioned as positive. In spite of the women being in a minority in the groups the teachers did not think that they had been disadvantaged or subordinated. On the contrary, according to the teachers, women talked quite as much as the men, and could express their own ideas more freely than in a traditional class.

One of the basic ideas in the planning work was that PBL would provide a chance for women and their special perspectives on technology to add something to the ordinary content. However, when the teachers were asked explicitly about the women's specific contributions, this seemed not to have happened; the expected enrichment of the content by the female students had not taken place. The reason for this, the teachers believed, was that the female students had had such difficulties with the subject content itself. As it had been, they had studied for their exams and had not had time or energy to viewing the subject content in any other way.

None of the teachers thought that the content of the programme was gender-inclusive. On the contrary, they pointed out that the contents were like the ordinary computer engineering curriculum. However, they hoped that it would be different later during the programme; for example, they referred to the plans that the students would work together with students from behavioural sciences. And the teachers still thought that the programme had a different view of knowledge and a more open form than ordinary engineering education.

However, it showed in the interviews that this different view on knowledge was a different view of how knowledge is acquired, not of what knowledge is.[41] That is, there was a difference in the teaching method, which should have allowed for an extension of the subject content, for example by presenting alternative perspectives to it. But the view of what (relevant) knowledge is had not changed and so these alternative perspectives were not appreciated as knowledge with the same value and dignity as the established curriculum. Consequently, in practice there was no space for them on the programme. The perspectives which women were expected to take with them to the programme were seen as an asset which would have been nice to have, but they were not necessary for the functioning of the programme.

According to the interviewees, gender issues had not been talked of explicitly between students and teachers. A couple of remarks hint at the reasons for this. One of the teachers saw difficulties in introducing gender issues because they easily provoke resistance. Something about gender would be introduced, but later in the programme and cautiously, without lecturing:

> I'm not so sensitive, but I understand that among the teachers there is the belief that it's very important for students to meet these types of thoughts when it is very natural, otherwise it can be experienced it as if you're wagging your finger at them. (0209L)

Underlying the reluctance to discuss gender was the prevailing attitude in engineering education (and not only there) which sees gender issues as something normative rather than factual, something provoking opinions which lie outside the knowledge aims of the educational programme.

Another of the teachers talked about gender issues and women's perspectives as something that female students were supposed to introduce, not something that should or could come from the male teachers.

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[41] The problem of implementing PBL, which was the main concern of the teachers during the whole year, probably had its roots in this. In practice PBL was still seen as a teaching method for helping the students acquire certain knowledge, rather than a learning method resulting in a different kind of knowledge.

> **..That the tutorial group supervisor should ensure that we utilise the female perspective and...**
> Yes, the tutorial group itself should do that in that case. In those cases the girls in the groups should take it up. Then of course, those aspects should be discussed. (1209L)

This teacher, waiting for the female students' initiative, seems to be one of those who saw the gender perspective as something inherent in women. For this reason it could only be introduced by female students and female teachers. If the female students do not do it, it is not done. This way of viewing the issue had perhaps been strengthened by the tutor preparation preceding the start of the programme. Here gender issues were only taken up in the role plays simulating group meetings, by the participants getting to play different roles, sometimes connected to gender. This kind of preparation presents gender aspects as being something attached to a (female) individual, not a structural issue.

Thus, even if the teaching method could be regarded as gender-inclusive, the content of the programme could not, and there were no efforts to raise the consciousness of the students or the teachers as to gender issues. How did, then, the female students enjoy their studies, especially considering the fact that they were recruited to a programme described as cross-disciplinary and became shocked when they realised they were on an engineering programme?

The teachers on the new programme seemed to have more definite opinions about the matter than those teachers who originally set out for planning the programme. They had had a closer contact with all their students during the year, and may also have had a special interest in seeing whether the programme was gender-inclusive as expected. The teachers suspected that the women did not like their studies very much, but that they liked the educational environment and all the social activities at the university.

> Well, it remains to be seen how many remain, but for the most part they seem to enjoy it, even though they ask themselves a little whether it's just Linköping and their friends and so they enjoy. And how much they enjoy their actual studies. They're still a bit confused on that point I think. (0101L)

In conclusion, the lack of knowledge of the general issues of women and technology and women and learning, and the steering of the reforms towards making better education in general, rather than adapting it specifically to women's needs, was followed by an implementation where women were seen as an enriching element in the student body, but basically from the social aspect. Not much change in gender perspective seemed to have occurred – the female students had fallen in line with the men. However, those engaged in the project as teachers or planners were not troubled by this. At LiTH the problematics of introducing PBL overshadowed other concerns - the woman question, when it was seen as problematic, was postponed.

The programme in its context

The general indifferent acceptance on the part of the colleagues continued, and the teachers also had heard some negative comments, about PBL and about the softness of the programme. The failure rate in the first examinations was a problem both for the teachers and the students - but it even had its advantages in the institutional context. Failing exams is one of the devices of habitus formation in engineering education, and so the new programme, in spite of its oddity, could show itself as being on the right track.

> I have a little, rather nasty, comment, that it may have been good that so many failed in theme two, for our internal reputation, if you know what I mean? **Yes, I understand exactly what you mean.** Because the pass rate in theme one was so complete for the simple reason that they keep at it until they are ready...If you make a mistake, you get instructions, that was wrong, do it right now. It would be strange if you couldn't manage to pass then. The first time you fail, that is part of the job. So then it looks as though we're letting them pass, and there's a little risk that you get a certain reputation then. (0720L)

The reluctance in the acceptance of the central authorities of the university in the planning phase was not mentioned any more - but neither were positive reactions. In general the interest in the new programme seemed to be greater outside than inside the university.

The rest of the University was still perceived to have a wait-and-see-attitude. Of course it was admitted as a success that a programme in computer engineering had attracted so many women, but the special features of the programme were seen as the explanation - and these were seen as impossible to transfer to ordinary programmes. So the teachers did not see that the new programme would make a great difference in the general recruitment of female students. On the contrary, they were not even sure about the female recruitment next year. The programme was seen as a small and a very special contribution. If the female students on the programme could be retained, the programme would have fulfilled its own recruitment goals, but these female students were not seen as a kind which would also apply to ordinary computer engineering. And the new programme was not seen as a substitute for ordinary computer engineering, which naturally would continue and was seen as even in the future having very few female students enrolled.

The programme seemed still to be in the process of gender-coding, which may explain part of the teachers' insecurity about the future. A new educational programme will always be gender-coded. An engineering programme will most probably become coded as masculine, because of its context, even if there might be some insecurity about the matter to start with. Efforts to change the gender-coding can be made by marketing the programme differently, as more feminine (which the group at LiTH was very cautious about), or by introducing elements with another gender coding in the programme itself (which the group tried to do).

For the moment the programme had a mixed gender-coding as to the student body. However, as to the subject content it was similar to the ordinary male-coded computer engineering programme. If the first female students encountered many obstacles, the teachers anticipated that the programme would be even more male-coded. On the other hand there were no plans to make the content or other features of the programme more female-coded – for example because the cultural restrictions at the institution were not any more favourable for it now than during the planning phase. To this extent the teachers' opinion that the only thing which was really gender inclusive (or female gender-coded) with the programme was the composition of the student body seems to be reasonable. It seemed to be acceptable for both the planners and the institution.

Conceptions of female students

The basic ideas of what female students are like and what they prefer were kept quite intact through the first year of the programmes, even when there was no empirical evidence of their correctness. (An example is the assertion that women come with new perspectives in group work, while none of the teachers actually gave examples of this.) What was new compared to the interviews before was that the diversity among the group of women was stressed. The stereotypical images about "women in general" were complemented by the concrete experiences of female students, which the teachers had gained by working with their students more closely.

For example, the expectation of female students being academically very competent and with a better working morale than the males had taken some knocks. Some of the female students were seen as even less ambitious and goal directed than the men on the programme. While the teachers said that some of the women were very ambitious, they complained about some others. It may be that they only had one or two female students in mind – but they talked in generalised terms.

> ...one of my girls fell behind the whole time, and time after time when we had decided to do something it was always "yeah, no, I hadn't time" and "I didn't do it" and it was this usual defence mechanism that girls have because they are treated as non-adults, and I think that is wrong. (0709L)

Behind this kind of disappointment there might be common expectations that women should carry responsibility, not only for themselves, but for other people, too, while this is not expected of men. At the same time this responsibility for others was seen as negative for the female students' learning - the teachers blamed this for the female students' problems in concentrating on their own studies.

> Well, I really don't know what it looks like with regard to study results. But if I were to hazard a guess I would say that the girls need to learn the value of sticking at it and working quite hard. **Do they need that more than the boys?** Sometimes I think that boys are a little more used to it, but maybe-- I don't really know... Women are often goal-oriented but then it is the group, the family and relationships that are in focus. So I think that girls would need to learn that it's OK, that it's important that it's not just correct, but actually necessary to shut out a lot of things and be goal-oriented for their own sakes. (0209L)

None of the teachers mentioned having gained new insight into the problem of why girls do not come to computer engineering. In general the teachers still believed that, when all is said and done, it is something about the women themselves – their upbringing to a certain role or their misconceptions about the education or the profession – which keeps them from computer engineering. Some of the teachers had heard that more women than before now chose the natural sciences programme in secondary school and set their hopes on that - perhaps girls were starting to change at last.

Sex vs. academic orientation

This section stresses the importance of "academic orientation", denoting the cultural differences between different faculties (Becher, 1989), where engineering can be said to be male-oriented, while, for example, the culture of liberal arts seems to be more attractive to women, and is commonly conceived as more feminine. Academic orientation seems to make an important contribution to an individual's gender identity in engineering education.

The question of gender vs. academic orientation in this context relates to the Bourdieuan concept of habitus. If one of the tasks of engineering education is to furnish the student with an engineering habitus, what is required of the student to be seen as a suitable object for this process? The interviews with the teachers seemed to point to other features apart from gender.

While the interviews had as their point of departure a division of the students in two groups, men and women, the teachers often came with another division.

At LiTH the students with a social science background were four women and one man. It was not their being women which was seen as problematic, but their inadequate preparation for the programme. They were said to have great difficulties in their studies. This is not surprising considering the fact that the final design of the programme did not pay any attention to their different background. The planners had expected extremely gifted and motivated students who could manage engineering education without the same background in physics and scientific thinking as the other students. This did not come true.

Thus, an important requirement for becoming an engineering student is academic ability and the right kind of educational background. The social sciences students at LiTH could be expected to have had a high degree of academic ability, being chosen by a very selective process. But their background did not fit in the programme, not even the new programme which was originally planned to make use of and teach skills which they had acquired to a higher degree than the other students. Thus, in spite of what was said in the planning phase, a special kind of background, an academic orientation towards mathematics and science in secondary school, was required.

But the importance of right academic orientation is particularly illuminated by the way the interviewees referred to those new students who did not come from social sciences. Most of these students had the right science background from secondary school and very high grades, that is, high academic ability in the areas required. Still, many of these students, both the men and the women, were described by the teachers as generally different from ordinary computer engineering students,[42] and the image given was not favourable. Most importantly, these students were described as unambitious and not hard-working enough. They did not react to failed examinations the way the teachers were accustomed to, but became depressed and frustrated.

One of the teachers simply described the students as "liberal arts students".

> They are more open and positive and less work-oriented. They're more like students at the Faculty of Arts. (0209L)

These students can be described as having an academic orientation which is more common among liberal arts students than among students of science and technology (Jansson & Drottz & Sjöberg, 1989). They were interested in discussing, in trying to find a holistic view and in working in groups, rather than doing hard work with their problem sets to pass their examinations. The teachers found that there were both students with the right academic orientation, more like normal engineering students, and those who were too different to really succeed and manage the essence of engineering studies. For the teachers the difference between these groups seemed to be more important than the difference between sexes.

This clarifies a dimension in the question of women and engineering education. If engineering education has as its task, not only to teach engineering knowledge, but also to inculcate a certain habitus, a certain academic orientation is essential, in addition to academic competence and the right background. The students on the LiTH programme had the right background from secondary school and they had very high grades - but this did not make them suitable for an engineering programme.

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[42] This perception is verified by the questionnaires sent out during the first days of study to both ordinary computer engineering students and students on the new programme, where the answers of the new students formed a wholly different profile from the answers of the students on the ordinary computer engineering programme. In general students on the new programme seem to be different from ordinary computer engineering students. In the questionnaire they indicated that they were not very interested in computer technology. When choosing the programme, many of the men were attracted by the idea of subject integration and the integration of the social sciences in the programme, while many of the women had applied because PBL sounded interesting. The students on the new programme, especially the women, seemed to be very group-oriented.

They might have been just right for the original vision of the programme, which implied changing the male orientation of engineering education. But the vision was prevented from being realised by both the institutional context and the modes of thinking of the planners themselves. And there were problems with PBL, experienced both by the planners and the teachers. These problems can be seen to emanate from two sources: the difficulties of combining the method itself with the engineering content and the educational environment, and the difficulties of introducing the students attracted to the programme by the method to the engineering content.

There was also an expectation that changing the teaching methods to be more gender-inclusive would attract women with a suitable academic orientation to the programme. Instead a group of women and men with an unfamiliar and, as deemed by the teachers, unsuitable academic orientation were attracted.

General impressions from the first year at Chalmers

At Chalmers the number of female students more than doubled from 7 to 17 (out of 109) when the programme started. In contrast to LiTH, at Chalmers these students, both women and men, were basically seen as coming from the same pool as even previous students in computer engineering had come. The number of female students, 17 out of 109, was seen as satisfactory – already in the planning phase the actors had said they would be satisfied with such a result. By the time of the interviews the teachers knew that some of the female students had dropped out of the programme, but did not regard it as alarming, as some male students had also dropped the course. At that time, 4 male and 4 female students had dropped out of the programme, which makes a significant difference in retention rates if counted in percentages – which the teachers did not seem to do.

At Chalmers the reform was not as radical as at LiTH. As to content, the most notable change was a project about computers in society. This project course ran for 8 weeks and the students were to look deeper into some context of computer technology, suggested by the teachers, such as the history of computer technology, manuals for video recorders, internet education for grades 4-6 and so on. Introducing societal aspects of computer technology in this way during the first year of studies was something totally new. The amount of group work was also something new for the programme.

Other reforms included changing the mathematics instruction towards co-operative learning and changing the order of the first two programming courses. Mathematics and programming teachers more co-operated more than before in trying to co-ordinate some parts of their courses. Programming teachers also made efforts to pay attention to the content of the examples and exercises, trying to make them somewhat more relevant to the everyday reality of both female and male students.

At Chalmers the teachers praised especially the group teaching experience. The groups were composed so that at least half of the members of a mixed group were women, which resulted in some mixed and some all-male groups. According to the teachers the women had had no difficulties in their groups. The teachers thought that the women were quite capable of asserting themselves, and were not so different from the men. And according to the teachers the male students had not made any efforts to dominate the women.

The group tutors were largely unprepared to direct or observe group interaction, though, as the planned teaching in group psychology was not carried out, so what they said about women's position in their groups was more of a gut feeling than a result of close observation. They themselves had not experienced the lack of preparation as a problem, but remedying it was regarded as something important by the next year's course co-ordinator, a female faculty member from another, more human-oriented department.

No previous decisions had been made as to whether the groups would stay together the whole year, or just one term. As the question became acute by Christmas, the groups were allowed to solve this any way they liked - those who wanted to split up were allowed to do so, and those who wanted to continue could do that. Most groups chose to continue. However, one woman chose to quit her mixed group and work with an all-male group. In the interviews the teachers used her as an example to illustrate that the sex composure of the groups was really not that important Her changing of groups from a mixed to an all-male group was interpreted by all but one of the teachers as her personal preference for an all-male group, rather than severe problems in the mixed group.

The closer contact between teachers and students, which had been an effect of the group work, was seen as very good for the female students, who were described as more socially oriented. If something was seen as especially good for just women in this programme, it was the creation of a positive social environment by increasing the interaction between students and between students and teachers. It was said to be good for the men, too, but especially women were seen as benefiting from it. And the importance of the female students for creating a positive learning climate for all students was stressed even more at Chalmers than at LiTH. But while the number of women was regarded as sufficient to bring about a change in climate, most teachers did not find that the women on the programme actually had had any great effect on the curriculum.

> ...we were going to make our changes anyway but we were helped by the viewpoints the girls gave us and we get another atmosphere among the students if there are many girls. **Do the girls have different viewpoints than the boys?** Well, I can't really say that we've noticed whether that's the case this year, like, but that's what we have had in mind the whole time... And that has been the whole idea behind the reform that if we bear in mind what the girls want then we will also be doing things the boys actually want, but they--**But they can't manage to say it?** No, exactly. But then I think it means a lot for the atmosphere on the programme if there are girls involved. In that case fifteen percent is enough.(1107C)

So the opinion still existed that women were better at drawing attention to faults in the present education, and thus were good to have in making the education better for all, even if the female students enrolled on the reformed programme had not done this to any considerable extent. The more concrete contributions by the female students, mentioned by the teachers, were in the area of social relations, which was also in accordance with the initial conceptions of what women were expected to contribute. However, not all female students at Chalmers had conformed to the expectation of enjoying group work.

Another expectation, confirmed neither at LiTH nor at Chalmers, was the orderliness of the female students. At Chalmers this was exemplified by the deterioration of the new building. The students had not taken care of it, and this was spoken of with disappointment. First and foremost the male students were blamed for this, but the women did not seem to do any better. The women's room had not been made cosy, even if the female students had been allocated money to make purchases for it:

> ...I think it seems very bare out there... the cosy image I had, well, I imagined that's the way it would be, it hasn't become like that yet. And then I started to think, are the girls that are on the programme. aren't they interested in --? (0504C)

While the first year had been experienced as very tedious and problematic by the teachers at LiTH, both because of the difficulties in getting PBL to work and in subject integration, complicated with the "lack of ambition" of the students, the teachers at Chalmers were very satisfied with their year. When talking about their satisfaction with the programme, the teachers were not referring to gender issues, but to the good work done by the students and to their own situation as teachers. The new teacher role with closer contact with the students was highlighted. Nobody said that all the tedious and time-consuming work had not been worthwhile, and the reason seemed basically to be the personal rewards connected to the teaching situation.

At Chalmers the programme was referred to as a model reform for other programmes, and the teachers felt that their efforts had born good fruit and were looked upon appreciatively at the rest of the University. Here gender-coding was not a problem because the identity of the programme as the producer of (male) computer engineers for the needs of industry had never been in doubt. The institutional context was still perceived as very positive. The signals from the central authorities of the institution to the lower levels were told to clearly advocate the recruitment - and retention - of female students, and the reform was a case in point. The recruitment of seventeen girls instead of seven was regarded even by the institutional authorities as a proof of the reform being of the right kind.

But while no critical voices were heard about making reforms for recruiting female students, the really interesting parts for other departments were the pedagogical reforms. Reform work was starting on other programmes, too, and the teachers felt that they were seen as an example for the others to follow, at least partially, even if reforms in other departments did not have the label of reforming for women's sake. The programme had become what some of the reformers predicted in the planning phase, a flagship of the institute in pedagogical reform.

Implicit expectations on programming at Chalmers

Some of the teachers said that they spontaneously related their teaching to the needs of female students and that they were prepared to take women's opinions into account - if these opinions were expressed clearly enough. But generally the teachers, just like those at LiTH, did not mention changes in their own teaching, which would have come about because of the preferences or opinions of the female students, rather than the general educational thinking. The expectation that the new female students on the programme would better the education with their critical comments had thus not been fulfilled.

However, in one instance the presence and achievements of female students had affected new insights in the faculty into the content of the education. That concerned introductory programming.

The first programming course was in functional programming, because of the expectation that no students would have done this before, and so the male students who had a programming background would not have any advantages. This seems to have been a reasonable expectation as there were no apparent gender differences in the results and all students did reasonably well on the course. However, the second programming course in imperative programming was a disaster for the women.

> ...The exam for the first part went well for both the boys and the girls, but the exam for the second part went very badly for the girls and it's very hard to know why but what we learned was that in the first part they learned a new language, completely new. None of them had seen it before and we start slowly and all that so it goes well even for those who haven't programmed much previously. Then in part B we take up a language that most of them recognise, certainly those who have programmed before. And those who have programmed a lot before have certainly a lot, you can manage much better there... something that's difficult with programming is that most of them have done it before but there are still ten or fifteen percent who haven't done it before. (1616C)

Both the teachers and the project leaders were concerned about this and acknowledged that the level had been too high for many students, driven up by the male students who had programmed before and who could use the group tutoring sessions to discuss questions which were not relevant for the real beginners, and in this way taking tutoring time which could have been used better for the benefit of the beginners.

This experience from the programming courses was an interesting one, as it might illustrate the phenomenon of the implicit requirements of previous knowledge which the actors were aware of in the planning phase, but which was still there once the courses started. It is a striking example of what Bourdieu & Passeron (1977) find at the root of the daily practices in educational reproduction: the different backgrounds of the students, and the unwillingness or inability of the educational system to take them into account. Many of these differences are simply not seen, as education is practised by teachers for whom much of the knowledge base is self-evident.

The success of the women on the first programming course and their failure on the second clearly signalled to the teachers that the course, which was on the same level as first programming courses normally are, actually required some programming background for the student to be able to succeed. Women's success on the first course had proved that they could learn programming, and so their failure on the second must be blamed on the course rather than on the students' academic ability. This insight emerging from the women's results could perhaps change the situation even for the male students without a programming background. Their failures could not just be blamed on their ability, which might have been the case before, but also on the possibility that they might only have the officially required preparation and not the one that teachers implicitly expected.

The idea of switching the courses was acknowledged as appropriate - it had revealed the problematics. But the general opinion was that something should be done about the second programming course, to keep it truly in accordance with the course description and the stated requirements of previous knowledge.

> **But are you going to maintain the same order, that you start with the functional languages anyway?** Yes, I don't think anyone questions that. It went well, and three quarters passed the exam and they thought it was fun and...thus we have a feeling that they have learned quite a bit of functional programming, so it has worked well. **So it is the other one you have the problem with?** Yes, it's exactly that problem, of prior knowledge or not prior knowledge. (1616C)

The second programming course would be levelled in some way the following year. However, the teachers also made it clear that computer engineering is demanding and has to be demanding and that it is inevitable that some students drop the course. It was important that the image of a demanding educational programme be maintained towards the rest of the institution and the employers.

Problems with academic orientation at Chalmers

While the teachers at LiTH were clear about having received a student group very different from what they were used to, at Chalmers the students on the reformed programme generally were seen to be as of the same kind as during the previous years. [43] Both men and women were described as behaving more maturely, but it was unsure whether this was an effect of a different recruitment, or the different teaching method.

However, there was one deviant group, that of mature students, who had come to the university after years in working life and were financed by a new state grant for mature entrants. In a certain respect this group corresponded to the social sciences students at LiTH.[44] They were not seen as the right kind of students - even if, in contrast to the social sciences students they had a relevant academic background (completed secondary education in mathematics and science).

The group of mature students, both women and men, were perceived as a group with academic problems. There were three female students of this kind and all of them eventually dropped out of the course. Some teachers when explaining the attrition rates of women, pointed out that the figure included these women who could almost be expected to dropout of the course, and that the programme had been able to retain most of the ordinary kind of female students.

> And the girls have remained on the programme, all but three of the seventeen. And that is... I think that one was perhaps an ordinary one, so to speak , that came from secondary school and two were mature students who really didn't know what they wanted or what suited them. And it wasn't actually the studies but other reasons that made them... The young girls are still here, so to speak. (1107C)

Some of the other teachers saw these students as a real loss, evidence that the programme could not cater for "ordinary" women. These teachers would have liked to have a chance to give more help to this kind of students, who could be expected to have difficulties.

> ...She felt that she didn't fit in here. **And what else does she say about that?** Well, she thinks it's heavy, she has completed her secondary education at the municipal school for adult education and so on...And I thought, she wasn't exactly a star at maths but she

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[43] This is, by and large, confirmed by the questionnaires, when the answers of students from the reformed programme are compared with the ordinary computer engineering programme at LiTH. The number of women was very low in LiTH's ordinary computer engineering, but their answers were quite similar to most of those from the female students on Chalmers's reformed programme.

[44] At LiTH very few students of this category were admitted to MSc engineering programmes, and the IT program did not take in any.

> wasn't the worst in the class by any means. So I'm not sure there, she probably would have managed if she could have worked a bit on it, of course. But, like, she, eh, she had children and so, she probably felt that this was not the right place for her. And that's a pity really, because in a way it's that kind people we wanted. And you can't just attract them here and then when they come drop them in at the deep end and pretend that nothing has happened. (0019C)

Here two opinions as to who is eligible to become an engineer are apparent. Some teachers believed that mature students who have difficulties in their studies might well succeed and become a contribution to the profession if their special situation and difficulties were taken into account. The most common opinion, though, was that those mature students, be they men or women, who cannot adapt to the present requirements of the study form are not a great loss if they quit. Their lack of present study skills and inability to cope with the precise requirements of a university of technology disqualified them as desirable engineering students. This applied both for men and for women.

These teachers held firm to the ideology which is normal in the educational system, according to Bourdieu & Passeron (1977), namely that of treating everybody the same. It is this ideology, Bourdieu & Passeron assert, that perpetuates reproduction, as pupils from the dominated classes, who with their background find the educational system too foreign and demanding, do not get a chance to acquire the cultural capital needed. In contrast, those teachers at Chalmers who would have liked to give extra help to the mature students seemed concerned that even they, with their background should have a chance to succeed. They saw the problem in structural terms: it was not a question of a few unsuitable students dropping out of the program, but a question of structures which excluded students with different backgrounds and so ensured that the programme, in spite of the reforms, would continue to reproduce a certain kind of engineers.

Summary of chapter thirteen

There were both similarities and differences between the two programmes. Both of them succeeded in increasing the female enrolment in computer engineering. But while the teachers at Chalmers were satisfied with their students' achievements, the teachers at LiTH found themselves with a type of student which they were unfamiliar with and which they did not quite know how to handle to make engineers out of them. On both programmes the presence of the female students was appreciated by the teachers.

In general the teachers were satisfied with the position of women on the programmes. The protests and problems of the women on the LiTH programme were seen as a result of misleading information, which had attracted students on false premises. Instead of using it as a basis for reform to accommodate the programme to this kind of students, it was disregarded. At Chalmers the atmosphere seemed to be more open for criticism – but there was not very much of it. And even here, profound changes which could be suggested by a different student group (the mature students) were not deemed to be relevant or possible. The place of women came to be a feature of the education and the reform.

The lack of knowledge about issues such as gender and technology, gender and learning or gender in group dynamics, apparent in the planning phase was no less apparent among the teachers of the first year. There was a consciousness that female students' needs have to be catered for, but there was no basic guidance on how this should be done. In general, the situation of tutoring a group was in itself quite new for most of the teachers. This also made for shortcomings in catering for the female students' needs. Both at LiTH and at Chalmers there were examples of unreflectiveness as to how the teaching was adapted to women's interests and background.

However, the importance of the reforms should not be belittled, either. There is no reason to believe that these programmes would not cater for female students' needs better than an ordinary computer engineering programme. And to the teachers, they had brought a closer contact with female students, now that there were many more of them, and the teachers got to interact with them more because of the teaching methods. This interaction had probably increased an intuitive knowledge and nuance to the image of "a female student" among the teachers.

The teachers made an implicit division of female as well as male students into those who were suitable to become engineers and those who were not - and in that respect other factors were more important than gender. To be a suitable engineering student a certain orientation towards the studies, in addition to relevant secondary school background and academic competence, was required. It may be that this orientation (values, study habits, ways of relating to other people, priorities as to usage of time etc.), which is closer to an engineering habitus, is more common among men than among women, and that it is this aspect of female and male gender that counts for a great deal of the problematics of gender in engineering education.

The institutional attitudes to the programmes were quite different at the two sites. The programme at LiTH was very radical in its context (albeit only pedagogically), and even if the recruitment of women had been impressive it was not generally applauded. Rather this success might have made the rest of the university even more wary and made them postpone their comments after the programme had shown whether it was a "real" engineering programme or some kind of miscreation. The gender coding of the programme - seeing it as a "real" masculine engineering programme or a feminine "miscreation" - can be expected to be connected to this.

The reform at Chalmers was less radical and less suspect. The percentage of women recruited was well within the range of being enough to make a notable difference but not so great as to arouse stupefaction. Something similar might be said about the reform, which was radical enough to be interesting, but not so radical as to arouse opposition. And the increase of the percentage of women was of a suitable size to be seen as one of the positive features in the reform.

Very little has been said about the men on the programmes in this chapter. One of the underlying questions is whether the programmes primarily were better programmes for women and, as a side effect even for men, or whether they were better programmes for men, and so even better for women. Both these programmes can be applauded for recruiting many female students. However, they were not described as gender-inclusive by those engaged in them on a daily basis. There were many women and they made an impact on the atmosphere of the educational environment, but they were generally described as a feature in the education. The way the teachers talked about the programmes was not as gender-inclusive programmes which even men found attractive, but as engineering programmes (a masculine concept) which had even managed to attract many women.

14. Discussion of the results

What happened at the two universities with the two reform teams can be looked at from different angles. Doing a study on the introduction of new pedagogical methods in higher education would probably be the most evident one, because that was the main concern of the two teams. However, I started to follow the process with questions about the constantly ongoing genderization of technology in mind, and it was with answers related to those kinds of questions that I emerged from the process. It seemed reasonable to relate my questions and answers to the conceptual framework of gender contracts. Soon the concept of reproduction also became relevant. My observations show how very sluggish change processes are, and some of the factors which restrained the processes. Many of them relate to gender contracts. For members of the reform teams, making computer engineering education gender-inclusive meant being caught in several contexts of ambiguity. While it is commonly agreed that more women should go into computer engineering. this would mean breaking gender contracts according to which computer technology is a male domain.

This chapter starts with questioning the assumption that the recruitment figures of the new programmes are evidence of their gender inclusivity. This is followed by a short summary of the results of the study, related to the principal research questions. The remaining sections elaborate these results more in detail, and relate them to the theories of Bourdieu, Lundgren and Hirdman. To start with, a short explanation of how Bourdieu and Hirdman are related to each other in this context is provided. Some reflections on what happened in the interplay between state authorities and the Council are presented next, followed by a lengthy section about the different contextual factors on the group level and institutional level, restricting the realisation of radical gender reforms. Then the reform work is viewed, first in terms of reproduction through habitus formation and then in terms of gender contracts. Eventually, some reflections on whether and how gender contracts in computer engineering can be changed at technical universities are presented.

The chapter mentions change more often than reproduction. True enough, it says that changes are small or incomplete or concern details which are not directly interesting from a gender point of view, but still there is change. Change happens in the framework of reproduction, but whether it disturbs the reproduction or not, especially in the long run, is not always possible to tell. To some degree it is in the eye of the beholder whether change or reproduction is in the foreground. I choose to see primarily the reproduction that goes on in spite of the changes – though I could have chosen to put most weight on the changes against the background of the reproductive frame. Both Bourdieu and Hirdman are reluctant to introduce change, and following them I conclude that the odds for profound change are small in the reproduction of the basic gender contracts in computer engineering education. But at the same time change does exist and there is no definite answer to what it will have done to reproduction in the distant future.

Is gender inclusive equivalent to recruiting many women?

As to recruiting female students, the programs have been successes. The recruitment numbers went up considerably.[45] However, the attrition rate for women at Chalmers has been significantly higher than that for men. At LiTH the attrition rate of the first group of students after the first four years is only slightly higher for men than for women, but more of the female than of the male students conduct their studies in a slower pace taking terms off, so the percentage of women in the present group is lower than in the beginning. Thus, even if the programmes succeeded in their aim of increasing the percentage of women among engineering students, there might be reason to believe that they were not unaffected by the gender-related problematics in their creation.

Recruitment and attrition numbers are a measurable aspect of an educational programme. However I am not only interested in the number of professional women entering the computer industry, but also in what possibilities they have for "creating new areas combining what we want to develop with that what is unavoidable considering political - and economic - climate" (Elkjaer, 1989, p. 206) Even if both programmes recruited female students, as basically similar to ordinary programmes they would still socialise these students to traditional values in computer engineering and not encourage them to create something different. As seen in Chapter 3, the concepts of a female program (a program where there are many women) and a feminine program (with characteristics recognised as natural and desirable for women, for example by women considering of applying to the program) are not synonymous.

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[45] See Appendix 7 for recruitment and attrition numbers on the new programmes.

However, there are no definite criteria for evaluating a curriculum reform from these more implicit aspects, especially in engineering. Lewis (1993) and Rosser (1996) have tried to elaborate more in detail what is required for technical and scientific education to be gender-inclusive. They emphasise different aspects, and so can complement each other.

Lewis (1993) finds three issues to concentrate on in reforming education: 1) the construction of the curriculum against the background of different students, 2) student/student interactions, 3) teacher/student interactions. In the construction of curriculum, male and female spheres of everyday life should both be addressed, and teachers should be alert to implicit requirements of previous knowledge on the area. Student/student interactions should be monitored, at least to the degree of condemning sexist behaviour in the presence of teachers. And teachers should learn to pay attention to differences in their own behaviour towards male and female students.

If Lewis's criteria are taken as a starting point, the changes made both at LiTH and at Chalmers are not very impressive. The curriculum content was hardly constructed at all with the different student groups in mind at LiTH and not to a great extent at Chalmers, either. As the programming teachers at Chalmers found out, previous knowledge was still implicitly expected in their subject area – and it is not improbable that this was the case in other areas, too.

Further, real change, according to Lewis's criteria, should have meant increasing the awareness of the teachers of their attitudes towards and treatment of male and female students, respectively. This would have required more knowledge among the teachers about the gender-determined patterns of interaction in educational settings. In addition, the importance of paying attention to and monitoring student relationships, especially in the working groups, would have been impressed on the teachers, and it would have been essential for them to learn more about tutoring, especially of mixed-sex groups. These aspects which can be regarded as essential for gendered change to take place in a male-dominated educational setting were also neglected by both reform groups. Practically no attention was paid to how the monitoring of student/student interactions was to be done especially in regard to gender relations, and there was no common reflection on student/teacher relationships concerning gender, either. The whole area of the "chilly classroom" phenomena (Sandler & Silverberg & Hall, 1996), which is known to affect female students negatively, was left without consideration.

Rosser (1996) enumerates different stages through which curricular content reforms have to go to result in gender equal science education. Even if she writes about science, her stages have also been used to describe gender awareness in engineering education.

1. Absence of women not noted.
2. Recognition that science has a masculine perspective.
3. Identification of barriers to women in science.
4. Search for women scientists and their unique contributions.
5. Analysing science done by feminists/women
6. Science redefined and reconstructed to include us all.

(Rosser, 1996, p. 245 f.)

Even if these stages are not followed in order from one to six, they can be an aid in evaluating a curricular reform.

If the reforms had filled the criteria in Rosser's (1996) list about gendered curriculum transformation in science, the reformers should have acquired some insight into, for example, what the masculinity of technology implies, what really are the barriers for women in technical education and technical careers, what women really do and have done with computers (not only female engineers), and what could be seen as female aspects in computing and how they could be integrated into the curriculum. In addition the practical implications of these insights would have been reflected on in the project groups.

Lewis (1993) omits the aspect of teaching methods, which were what the reform teams concentrated on. While this aspect is mentioned by Rosser (1996), changing teaching methods cannot be seen as sufficient for making an education gender-inclusive. On the basis of Lewis and Rosser the main criticism of especially the LiTH programme is perhaps its concentration on teaching methods, which is only one of the aspects that need to be taken into consideration to make a programme gender-inclusive, and neglect of the equally important issues of curriculum content and interaction patterns. In addition, a basic prerequisite for change according to both Lewis's and Rosser's criteria seems to be increased awareness and knowledge of gender issues among the staff, resulting in cognitive and attitudinal change. Hardly any measures to achieve this were taken at LiTH, and few at Chalmers.

The official evaluation of the reforms initiated by the Council, was positive, and both the chairwoman of the advisory group and the secretary of the Council were satisfied. Their satisfaction was based on the recruitment numbers. However, as we have seen, numbers do not necessarily break gender contracts and affect power relations, but may conceal an undiminished strength of masculine dominance. The ethos and values of an educational programme and the gender of the people who are dominating the daily interactions, are quite as important in deciding the gender inclusivity of the programme as its numerical composition of men and women.

It is evident that the reforms made improvements in the functioning of computer engineering education. However, as was the motto at Chalmers, better education for women meant better education for all. It is not impossible that, as Rosser (1996) points out, an education which is created to be gender-inclusive, is shown to be even more friendly to men. In that case gender equality may not be enhanced.

Thus, these two reforms had taken small steps towards a gender-equal curriculum. Those steps which were taken – above all more collaborative teaching methods, and to some extent a wider perspective on computer technology – lay as much in the interests of male students and the future employers as in the interests of women.

The results in summary

Before what happened in the reform teams is reflected on in terms of reproduction of gender contracts, a short summary is presented of different aspects which affected the curriculum reform processes especially with regard to gender. These findings are elaborated on further in other sections in this chapter.

There were certain stereotypical *conceptions about women,* at least by the time the work had been going on for some time. Women in general were seen as non-technical, and women in computer engineering were seen as exceptions to this rule. Instead, there were assumptions about women's responsible rationality and their sociability. The non-technicality of women was conceived both as positive in stating that women are interested in the societal aspects of technology, for which there is a need in the education, and negative, in stating that their responsible rationality and sociability are disadvantageous for the kind of learning strategies that are needed at a technical university.

These conceptions of female students steered the reform work. The conception of women as inherently non-technical implies that women are seen as an additional element in a technological education, rather than an inherent part. It also implies that an activity, or an educational program, where there are many women easily becomes defined as non-technical.

Gender relations in the planning work were also influenced by this conception of women in computer engineering as special. While they, because of this definition, had a relatively equal position in the group, they nevertheless risked being regarded as outsiders if they stressed that they were women, for example by asserting the gender aspects of the reform. That is, the group functioned well, as long as it did not address gender issues.

The definition of women as special also gave them an excuse for not talking about gender - being special they could hardly be expected to advocate concerns that had to do with those non-special women which were to be recruited to the new program. However, from the men's viewpoint, the definition of women as women included the implicit expectation that it was they who were to take up gender issues. This double definition of women in the team as not-quite-women thus provided both male and female reformers with *The reformers' opinions about gender issues in engineering education in general* hovered between the opinion that gender actually was not an issue for the education, but that the scarcity of female students could be attributed to factors outside the sphere of the university, and the opinion, introduced by the conditions for the project, that engineering education was not ungendered, but could be improved to make it more equal.

As engineering education has a quite strong socialising component, and as these reformers both had undergone this socialization and functioned as socialising agents themselves, (that is, they had both acquired a certain habitus and worked as agents in the educational system to inculcate it into others) they could not be expected to question the values and practices of the education outside certain limits. These values and practices often follow a masculine norm, thus really making the education gender-inclusive would have required ripping off one's habitus – which is not possible.

As the basic conceptions of women resulted in their being regarded as an additional element in the context, the natural perspective on gender problematics was that of discrimination. That is, what was said about women in the reform team was founded on a conception of women as a disadvantaged group in the context of engineering education, but not a group which could lay claims to thoroughly transforming the education. This perspective enabled the reformers to disregard a possible conflict between making a programme female-friendly and keeping it compatible with other engineering programmes.

The institutional context appeared to be very important in facilitating or restricting the reform in several ways. To start with, the context where the reforms were to be made was not only in need of female students, but also in need of other reforms. It was the problematics of this daily context which prompted the teachers to reform, but rather towards pedagogy than towards gender.

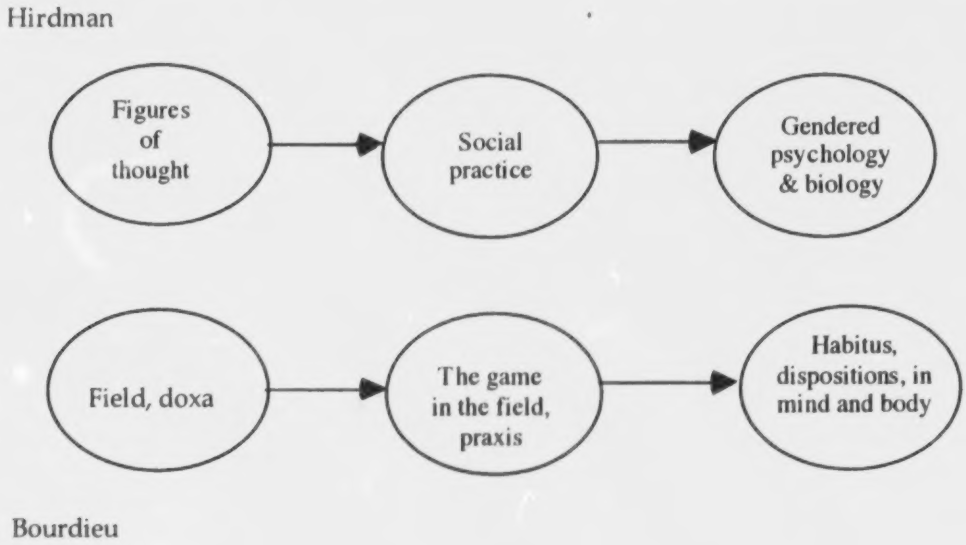
Furthermore, the attitude in the context towards the reforms was important. The reformers were not only restricted by their own incapacity to question the basic traits of engineering education, they were also restricted by their, often reasonable, assumptions of what kind of changes were possible to make without risking the existence and reputation of the program too much. However, it was difficult to know about all the pitfalls, as there could be assumed to be considerable differences between the rhetoric and the actual opinions as to the recruitment of women. The situation at the universities was ambivalent: on the one hand it was hoped that female students would strengthen the recruitment base, on the other hand the education in itself was not to carry feminine traits. The differences between the two universities depended to a great extent on the differences between the institutional contexts, but also on the fact that introducing something totally new to the context makes for another kind of difficulties than a more moderate reform of something already in existence.

I cannot say that these results are exhaustive, or that they are "objective" in some sense. They have been arrived at through a process of qualitative analysis, which tried to capture the lifeworld of the reformers, as it was expressed in meetings and in interviews, structure it by two overarching theories, and transmit the resulting picture to the reader. Even if the interview analysis was designed to eliminate gratuitous interpretations and to really look at what the reformers were saying, choices still had to be made which certainly reflected my personality, previous impressions of the reform process, my way of looking at gender and gender equality, my personal impressions of the interviewees and several other factors. A human tool, a researcher, working with interviews with multiple layers of meanings cannot be expected to come up with one single and complete truth, just more or less "truthful" interpretations. The same applies to the theories which are used to structure the findings. They are certainly not the only possible ones, but just one of the possible ways of understanding the reform processes. However, understanding is the aim of this thesis and to that aim these kinds of tools have to be used, in spite of their shortcomings.

The worlds of Hirdman and Bourdieu

In my analysis of the reform processes I combine two theoretical approaches which seem to be very different. They come from two disciplines: history (Hirdman) and sociology (Bourdieu). Originally, they deal with different aspects of social life - Hirdman with gender and Bourdieu the reproduction of the power of different social classes.

However, there are some basic similarities which make it possible to use both in the same analysis. Both talk about the importance of praxis in the perpetuation of social order. Both stress that we become what we do, in interaction with others, and this interaction is based to a high degree on subtle principles which we do not recognise. For Hirdman, these subtle principles are the changeable figures of thought which give rise to social practices which, in turn, result in the formation of an individual as a gendered being. For Bourdieu, the basis is the struggle for positions in a field which is to a great extent based on the unrecognised doxa, and this forms habitus, that is, forms the individual. And for both Hirdman and Bourdieu this formation does not only concern psychological dispositions, but the whole individual, her practices and her body.


Hirdman
Figures of thought
Social practice
Gendered psychology & biology
Field, doxa
The game in the field, praxis
Habitus, dispositions, in mind and body
Bourdieu

When talking about gender and habitus, Hirdman and Bourdieu put the emphasis on different aspects of the process. For Hirdman the "changeable figures of thought" are what is primarily meant by gender, and praxis and individual gender follow from them. For Bourdieu the praxis, the game in the field, is primary, and habitus is related to that, while the underlying principles, the doxa of the field, are given comparatively less weight. However, all three elements can be found in both theories. (West & Zimmerman, 1991, can be used to put more weight on the interactional praxis level in gender formation.)

Both Hirdman and Bourdieu also believe in stability rather than change. The very basis of a Bourdieuan field is quite consistent - a crisis of one kind or another is needed to even shake doxa. The dominant groups see to their dominance being perpetuated by transmitting the arbitrary doxa to the newcomers. For Hirdman, the two principles behind gender contracts, separation of sexes and normativity of male, are also consistent. Gender contracts are renegotiated but only as much as is possible when keeping the two principles intact, so the male dominance is still perpetuated. For both theories change principally has to come from the outside; the objective conditions of the functions and survival of the system have to change in some way before the underlying principles can be questioned. (Even if both Hirdman and Bourdieu mention human reflexivity as a possibility for being liberated from the prevailing world view, they do not build on this possibility.)

When using both Hirdman and Bourdieu in this study, I am concentrating on these aspects which are commensurable to a sufficient degree. What is called reproduction of the power of the dominant class by Bourdieu would be called the perpetuation of the basic principles of male domination by Hirdman. And what is called the renegotiation of gender contracts by Hirdman would be called the power game in the field by Bourdieu. Bourdieu's special contribution in this study is the idea of education as reproduction of power, and the importance of habitus formation in this context. Hirdman's special contribution in this study is the idea of gender contracts and how the contracts on different levels work to perpetuate male dominance. While Bourdieu explicates how reproduction works, Hirdman defines the area in which it is working.

The interplay between state authorities, the Council and the universities

In Lundgren's (1983) terms vertical reproduction refers to the "order" which the state places on the educational system to reproduce the work force needed. In this case - after the reformulation suggested by the Council - the order came to concern producing female computer engineers to fill the needs of industry for more competent work force on the area

In Sweden there is an official rhetoric of gender equality, which is part of the cultural overlay. This rhetoric includes the idea that both men and women should do technology. However, this is only a part of the contract on this level - other parts of it strongly imply that technology is a male area and in reality computer engineering is a male area. However, there are concrete, economic, reasons to change this. There are not enough men to fill the jobs in that area. The gender contract on the cultural overlay level today makes it possible to imagine women doing computer engineering. Thus, it lies in the interests of computer industry and the state that those parts of the contract which dispel women from the area of computer engineering may be changed to some degree. (It is very unclear, though, to what extent and in which positions women are welcome to computer engineering.)

The two reform projects were initiated in the context of vertical reproduction, and were to be realised on the horizontal level of engineering education institutions. These were allocated project grants as an incentive. For the purposes of the state the measure of success could be expected to be the change in recruitment numbers from the very beginning, rather than the curriculum of the reformed programme.

This initiative was further formulated and reformulated by the Council when the project grants were channelled through them. In the administration of the money this authority saw a chance to promote its own interests in pedagogical renewal. These interests seemed to be common with the interests of those who would be realising the projects. The vertically decided (re)production of computer engineers by making women a larger part of the corps started to halt here. The steering instrument of the state, the money, was passed to the institutional level below without clear options as to what was to be achieved in relation to gender.

This case follows Lundgren's (1983) argumentation on the interplay between vertical reproduction and the needs and preferences of engineering education (horizontal reproduction): in reforming computer engineering education, state authorities had their aims, intentions and conceptions of gender contracts, while the aims, intentions and gender contracts in the sphere of horizontal reproduction, the reform teams at the universities, were somewhat different. The Council was somewhere in between but should, in my opinion, in this case be regarded as part of the horizontal reproduction sphere, reformulating the interests of the parliamentary advisory committee and the Minister of Education into something that it regarded as more relevant than gender in the educational sphere. What from the perspective of the state authorities could seem to be a straightforward task of finding out what women wish from computer engineering education and reforming the education to comply with these wishes, became a complicated matter in the educational sphere, especially with the power relations and traditions in engineering education.

What happened in the process between the different levels of the system is remarkably free of conflicts. The Minister of Education accepted the reformulation by the Council of making pedagogical change the solution to the problem. The Council accepted what the educational institutions were doing and stated with satisfaction that the recruitment numbers had gone up considerably. The initiators, the advisory committee were also satisfied. What is commonly said about gender equality, that it is a touchy and controversial issue and very difficult to work for, does not seem to be true at all.

However, there were no reasons for conflicts, as the parties involved did not have any clear demands on each other and all of them had something to win in the process: The politicians could see themselves as satisfying a need expressed by the computer industry for more competent computer engineers and showing their commitment to the numerical gender equality ambitions of the Swedish gender equality politics. They were shown the recruitment numbers, which fulfilled their aims with the project. The Council saw a possibility to administer a major amount of money and a major pedagogical change - and pedagogically the reforms were radical. The reformers themselves could gain an experience of professional growth. The only conflict occurred at LiTH, where the institution itself doubted the benefits of the new programme, while the institutional authorities at Chalmers saw that the reformation of computer engineering would benefit reform work at the whole university.

Thus, defining the aims of the reform in wider terms gave something to all involved and so, in the words of Lindensjö & Lundgren (1986), it was more important to see something being done than to formulate clear targets and monitor the process. This might well also be a consequence of gender issues being touchy, and fundamental contracts being at stake, if change is really to succeed.

University of technology as a context for gender reform

While the previous section discussed the basic task of the projects, relating to the concerns of vertical reproduction that is supplementing computer engineering corps with more female members, this section looks at how the reforms were restricted by mechanisms of horizontal reproduction.

Lundgren's (1983) concept of horizontal reproduction can be said to denote the sluggishness of educational institutions. They have their traditions which they guard. The task of engineering education institutions is not only to impart engineering knowledge, but also to form in their students a certain habitus. Several aspects in the organisation of the education and the institutional traditions work towards this habitus formation, even if this is often unconscious both on the part of the teachers and the students. This is one reason for the reluctance to change. Gender contracts are, of course, part of these aspects and traditions. The habitus of an engineering teacher, being educated and working in this context, also includes the prevailing gender contracts. As these are deeply imbedded in the institutional context and in the habitus of the teachers, even of those working for a reform, they are difficult to change.

But this study also shows that engineering education institutions differ from each other, and in spite of the similarities in the habitus inculcated, gender reforms are easier to make in some. The reformers, with their dispositions, are acting in a context which can both restrict and facilitate change. The main difference in the institutional contexts of these two reforms was the different attitude of the institutional leadership. Even if the reformers had perceived gender contracts the same way on both sites to start with, the differences in the context would naturally result in differences as to the gender inclusivity of the programmes.

However, on neither of the sites were the reforms radical in regard to gender. There were several aspects in the context that supported the reproduction of underlying gender contracts.

A need of other reforms should not be a problem for creating a gender-inclusive programme, but in practice it was shown to be so. It was because there was an immediate need of a pedagogical reform that both universities started their projects. During the course of the project it became apparent that at both universities, though to a higher degree at LiTH, the pedagogical reform pushed out the gender reform to the margins of the agenda.

Fish (1995) enumerates some reasons for an engineering education institution to engage in gender reform, for example external pressure, conflict, change agent, continuous improvement process and changing consumer market. She finds that the need for gender reforms is often not experienced personally by the faculty, but has to be induced. There was nobody to really induce the gender reform at LiTH, and other interests became more important in the planning process.

Making a gender reform is both more profound and more difficult than making a pedagogical reform. The teachers involved did not experience the gender composition of the programme as a problem the same way as the pedagogical methods they were working with. Besides, especially at LiTH there was an institutional atmosphere of doubt when thinking about the possibilities of recruiting women. As Lundgren & Lindensjö (1986) spell out: when the reformers were confronted with something difficult and something that did not directly concern their daily problems, they reformulated the project so that it dealt with something else. In this they had support from the Council – already on that level the intentions of the Ministry of Education had started to be reformulated to something else than gender. Maybe it was necessary to reformulate the goals to effect any real change at all. An invitation to create merely gender-equal education might not have attracted a sufficient number of interested men - and in their minority position any interested women would have been able to make only marginal changes.

Sociological and psychological knowledge is hardly imparted by engineering education, and even less so knowledge about gender issues. Consequently, the reformers themselves did not know very much about research on gender in general, and research on gender and technology in particular. This allowed, naturally, the overarching gender symbolism of the society (such as technology belonging to men, or women being sociable) uncontrolled space in the reform work. A special consequence of this lack of knowledge was that being a woman was seen as a merit in itself in the planning work.

There was also a lack of knowledge about the areas which were not part of the present engineering education, especially social sciences. The group at LiTH, even when supplemented with a social sciences representative, lacked knowledge and, consequently, ideas of alternative curricular contents, and what they could imply. With very little initial knowledge and interest in acquiring the knowledge, the members of the reform group lacked the ability to discuss the suggestions made by the social sciences representative. Her position in the group became marginal in the internal struggles and positionings of the representatives of "real" engineering subjects.

The problems of open resistance were the minor ones, but it could be suspected that there was underlying resistance to any radical measures. In this respect there was a great difference between LiTH, where the reform team worked on its own, and Chalmers, where the reformers were very conscious of the support and interest (even in the gender issues) of the institutional authorities. At LiTH it was unsure how the institutional context actually viewed female-friendliness, and the reformers may have been disproportionately careful. (For example, it seemed that the governing board actually was more positive to gender issues than the reform team had expected.) At Chalmers the reformers felt a little pushed to consider gender – when they did not, they at least felt that they should have done it. At both universities the reformation of the education came as the first concern, and the difference in the importance of gender issues on the agenda was to a great extent due to the expectations of the institutional context.

The two different approaches, creating a new educational programme and reforming an old one, led to different problematics. Reforming an existing programme meant that many people had to be involved - even those who might not be very interested in gender issues. Creating a new educational programme made it possible to keep the reform work in a small group, but it also made it possible for the reform group to get relatively isolated in the institutional context.

Even when planning for a change, the reform groups were preserving and honouring much of the heritage of engineering education. A part of their habitus entailed viewing engineering education in a certain way, not seeing any reason to question many aspects which could have been discussed from a gender perspective. At LiTH, stating that these students would take a master's degree in engineering, laid several constraints on the possible reforms. The most notable was perhaps that laid on the curriculum content. The original idea of the project leader seemed to follow Bratteteig & Verne's (1997) recommendation of turning the present value structure of computer engineering upside down, in devaluing narrow technical skills and upgrading those students who could keep track of the complex reality, but in the course of the process this idea had to give way to the regulations, explicit and implicit, of what an engineering curriculum is like. These regulations still build on technical and mathematical problem-solving skills. The only way of substantially increasing the amount of content which was expected to appeal to women (social sciences, languages and communication skills) was seen to be lengthening the programme. The core of engineering subjects was not deemed as possible to diminish more than marginally, if these students were to be seen as equivalent to those coming from the ordinary computer engineering programme. Even if the amount of social sciences came to be higher on the new programme, the curriculum content was still basically modelled after ordinary computer engineering.

But not only the curriculum content had to be modelled according to the heritage. The features which cause Seymour & Hewitt (1997) to call engineering education an initiation rite, with challenge as one important concept, still had their hallmark on the programme. Even if the teachers expected, and found themselves, to be more nurturing than on ordinary programmes, during the planning phase it was clearly spelled out that no "spoiling" was appropriate. The opinions differed, but the attitude of "sink or swim", which would make the students "swim" existed during the first year's studies at LiTH. The workload was also planned to be on the level with other engineering programmes - and the fact that the students were not working on their problem sets the way other engineering students did was experienced as a major problem. The low pass rates in the first exams were a problem, too – but having much higher pass rates than other engineering programmes would also have meant problems. In that case the programme could have been looked down upon.

The decision at LiTH of to model the programme as one of computer engineering put it on one side of the technical-masculine/non-technical-feminine divide, and attaching the tag of a master of engineering programme to it defined several frames for both the curriculum and overall ethos which the planning group could not transgress.

For the reformers at LiTH the image connected to the status of the programme became an important issue. The idea of creating a whole new programme instead of changing the existing one was natural. One of the reasons was that the existing computer engineering programme was perceived as functioning quite well, and not in need of special reforms. Trying to make profound changes in it "just" for the sake of recruiting more women would almost certainly have met resistance.

But just the fact that the educational programme was to be all new caused problems. A new programme could, more easily than an old one, be questioned and criticised and risked being regarded as inferior. This was a problem especially because of the expected number of women on the programme. Because the programme would be new and small, it was not inconceivable that the number of women would make a sizeable percentage of the student body, and thus make the programme visibly gender-inclusive.

In the masculine context of a university of technology a gender-inclusive programme is something new and strange. As women and technology are seen as incompatible, a gender-inclusive engineering programme is a contradiction in terms. If a programme is female-friendly, certainly it means that it is less technical?

It was this suspicion that the reform team at LiTH had to work against. They had a need to recruit female students at the same time as the education should not be presented as adapted to women. They should recruit women, but at the same time not repel clever male students. There was uncertainty whether clever female students would be attracted or repelled by a programme with a gender-inclusive image. The future employers seemed to ask for female engineers, but an education which would be adapted to them, instead of following the old norms and traditions might not be well received.

The strategy of the LiTH team in the midst of these contradictions was to stress the engineering aspect of the programme, and tone down the female-friendliness. As we have seen, it resulted in ambivalence among the reformers and contributed to the silence about gender in the group meetings. As the reformers themselves did not seem to be certain that this cultural assumption about women's non-technicality was false, it was all the more problematic to take care that it would not be realised in the new programme. Even if the general opinion is for gender equality, even if the lack of female students is experienced as a problem at the university, having many women on an engineering programme decreases rather than increases its status, and so the status has to be secured in other ways.

The group at Chalmers did not have these problems. Because they were making more moderate changes to an existing programme, they could still expect young men from the region to apply. The expected percentage of women was not enough to disturb the masculine image of the education.

Thus, while it can be expected that it is difficult to make changes in an established programme, it seems that doing something radical when creating a wholly new programme, which has to be established, is not much easier. In some cases it might even be safer to make gender reforms to a programme which has both a firm recruitment base and a certain industry ready to swallow the graduates. Their limits as to the tolerance of gender reforms might be easier to anticipate than those of a wholly unknown group of applicants and employers.

Conceptions of what women and men are like belong to the cultural overlay level in Hirdman's framework. Among the reformers there were both general conceptions of what women and men are like, but also conceptions that pertained more specifically to the culture of engineering education institutions. These conceptions probably changed during the reform process, as the process in itself included doing gender in different ways. Gender was defined by the expressed assumptions of women's sociability and responsible rationality. Gender was also defined by the interactions in the group. Picking up many women to represent women's interests defined gender as a women's issue, and women as inherently interested in gender issues.

There were three aspects which were curbed gender contract reforms on institutional level: a) Stereotypical, unexpressed assumptions about women in general; b) The view of women in engineering being different from women in general and c) The view and expectation of women in engineering and engineering education as being a feature rather than an equal part and agents for profound change.

a) The general conceptions about women, which were expressed by the reformers in the interviews, were very much those which are conveyed in different daily interactions in the society in general - even if they are often subdued or masked in public discourse. They are expressions of the societal gender contract on the symbolic overlay level. Most were never formulated publicly in the reform process, but only came up in the interviews, and their steering effect was not taken into consideration, even when they contradicted the expressed ambitions of the reform – for example when problem-based learning actually seemed to contradict the assumptions about women's learning styles.

Some of the overarching concepts were formulated in the argumentation for increased recruitment. Responsible rationality and sociability work were referred to, in expecting that the women would take in societal aspects in their technological problems and in expecting that the women would make the atmosphere nicer. As to the responsible rationality, not much of it was seen by the teachers during the first year, and especially at Chalmers, the most visible features of sociability work, such as caring for the cosiness of the premises, were conspicuous by their absence.

b) The view of women in engineering being different from women in general was the other factor which restrained the female members of the reform groups from discussing the needs and preferences of the students to come. This view can be expected to be the result of the breach which women in engineering have made in the gender contract designating technology as a masculine area. Rather than changing the contract, admitting that engineering is also a female occupation, the contract is seemingly kept up by asserting that those individuals of female sex who go into engineering are not actually women, but something else. In this way a special kind of gender contract is created for them.

Of course the view of women in computer engineering being special is true in some sense. If nothing else, they often have an unusual interest in mathematics or computers. It is good to acknowledge that if women who go into other areas today are to be recruited, they might have other needs and preferences. But the idea becomes problematic if 1) women in general are seen as an unknown species that is to be introduced into the institution or if 2) women who have entered the institution are counted as special computer engineering women, and in that way should not require any other considerations than the male students.

c) The view of women as a feature in the masculine environment of engineering was never expressed in the group discussions, either, but only became discernible in the interviews. It implicates the present gender contracts being so solid that a profound change in them is not imaginable. This naturally implies difficulties in affecting profound change in the gendered practices of engineering education, too.

As can be seen both in case of the female students at Chalmers and one member of the LiTH team, women who chose to speak on gender issues could influence the planning process, at least to some extent - at the cost of feeling awkward sometimes. But most of the women chose not to do so. This is understandable when considering, not only women's situation in the reform teams, but their total situation, that of women who were making or had made a career in a strongly male-dominated organisation. According to Becher & Kogan (1992), individual faculty members are realising role expectations and private goals in their daily work – and these did certainly not prompt the women (and not the men, either) to bring up gender issues.

The gender contracts in male-dominated organisations follow a certain pattern, according to Kanter (1993). Women and men interact with each other following certain recognisable patterns, which are internalised and become part of the gender contracts. These patterns dictate that women are to have a subordinated position. This also becomes a part of a female members' habitus, and results in dispositions of handling social interaction in certain ways. A part of the habitus of many women in male-dominated organisations is trying to make no notice of their sex. That is why they cannot be expected to advocate women's issues. However, as "experts" of gender, because of the general lack of theoretical knowledge, they were expected to do precisely this, and that task was not taken over by the male reformers even when it was evident that the women would not fulfil it.

Naturally, different women handled their position in different ways. An exception to the rule of keeping silent about gender were to some extent the female students at Chalmers. In part they might not have been fully socialised to the system, and besides, they seemed to keep in contact with each other about the reform work. The female faculty members taking part in the reform work did not otherwise come from the same departments and have close contact with each other. They had no arena of their own to discuss the role ambiguity the reform work put them in.

The female members of the reform groups thus seemed reluctant to talk about gender issues specifically, which is understandable considering their token position. Another reason given by them was the lack of identification with the female students who were to be recruited. As the cultural gender contract regards women as untechnical and men as technical, they also regarded the potential female students generally that way. However, as to themselves they had adopted an identity as belonging to an exceptional category, women interested in technology. They doubted that they could actually know very much about what women in the first category saw as problems with technical education.

Some of these aspects are quite obvious, primarily the need of other reforms and the lack of knowledge. Lindensjö & Lundgren (1986) point out that those who are to implement a reform take their point of the departure in their own daily concerns. It was quite natural that the reforms would concentrate on pedagogy, as that was the most immediate need experienced by the reformers. At LiTH this was expressed quite frankly. Another need was that of knowledge and expertise - even if the reformers themselves did not express this. Just these two factors could topple over intentions behind any reform - educational or other.

Some other aspects have to do with the context of engineering education, its seemingly benevolent attitude to gender issues, but the simultaneous need to honour traditions and basic values and keep up the status. While the reformers were aware of some open restrictions in the context (for example the need to consider the preferences of the future employers, or the need to consider the opinions of the present students, or the opposition to an abbreviation regarded as feminine), they were unconscious of how much internalised values and traditions really affected the reform work. The reformers often did not get so far as to see radically alternative ways of designing the curriculum. But even if they would have been able to do it, the consequences of several possible alternatives would probably have been resistance in one form or another in spite of the benevolent attitude in the context.

Conceptions of women and women's situation in the teams have to do more exactly with gender and gender contracts, and seemed generally to be quite unconscious for the reformers. Certainly, many of them were aware that they regarded women in engineering as different from other women. However, the sum of the general descriptions of women by the members of the LiTH team was quite inconsistent with the outlook of the reform ideas and the rhetoric in the team meetings. And neither the men nor the women seemed to have thought that the definition of women as special, or their position in the male-dominated context could have implications for their expected mission as gender advocates in the team.

Looking at the programmes as reproduction of masculine dominance

If the power balance between the classes - or genders - in the society changes, it may have effects also on the reproductive function of the educational system. When the unquestioned values, habits and meanings of the dominating class start being questioned, they cannot be inculcated with the same effectiveness by the educational system. In Sweden one of the areas which has started to be questioned is the exclusivity of engineering education as to gender. The official gender equality discourse sees engineering education as a legitimate place for women. Consequently, the masculinity of the education and the profession can be questioned and, if the power of the questioners is strong enough, even changed.

In Lundgren's (1983) terms the new programmes can be seen as processes in the course of reproducing computer engineering professionals (vertical reproduction) and reproducing the ideals and traditions of engineering education (horizontal reproduction). As these are both masculine, these reproduction processes also reproduce the masculine dominance in computer engineering. These processes can be viewed from a Bourdieuan perspective

According to Bourdieu, imparting a certain subject content in the curriculum to the students, giving them engineering knowledge and skills, is only part of the task of engineering education. Because the new programmes were to produce engineers, they also were expected to inculcate a certain habitus - for example in the form of working morals (where LiTH met some problems) or approach to technological problems, and attitude to technological innovation.

For some students it is easier to espouse this habitus, namely those whose habitus formation earlier in life is in keeping with what is expected at the educational institution. The basic idea of the reforms was that the teaching methods in engineering education were more in accordance with men's than women's dispositions, and that changing the habitus formation process by changing the working methods would make it easier for women on the programmes. However, this approach still left very much unquestioned. It became evident that there still were many aspects in the education which were more in accordance with men's than with women's previous experiences - especially those women (and even men) who had a different background than ordinary engineering students.

Not too much could be changed in the context, as the resulting habitus should not be too different from that of other engineers. Some differences were desirable, the new engineers should be more socially oriented and communicative, for example. But these were additional features rather than profound changes. The graduates from the programmes should still be clearly discernible as engineers. The programmes were still to reproduce a presently very male-dominated group of masters of important technology, and it was important for the reformers that their programmes would be perceived as doing exactly that.

Except for the outer constraints dictating the task of habitus formation, the effect of the reformers themselves having gained this habitus was discernible in the reform process, as could be expected from Bourdieu's statement, that the reproduction process is unconscious as it is carried through by pedagogical agents, which themselves have been inculcated in the dominant ideology. In the reform processes it prevented many questions about the gender inclusivity of different aspects of the educational context to be posed, as these aspects simply were not seen by the reformers - they were too self-evident to be perceived.

For Bourdieu the autonomy of the educational agency is one of the prerequisites for the inculcating process being hidden and therefore able to persist. In the reform processes it also became evident – the unawareness of the masculine features and traditions of the education that had their origin in the habitus of the reformers was not compensated by any outside force. The autonomy of the institutions was respected by the Council which, after granting the money, did not set up any procedures to make the institutions accountable for the planning work. In the practical reform work the autonomy of engineering education was showed by the reform groups almost entirely consisting of engineering faculty, even when the ambition was to broaden the outlook on computer engineering. This guaranteed most of the contextual factors of engineering education having been left unquestioned and able to continue their habitus formation practices.

What happened to the gender contracts

To change a gender contract requires, according to Hirdman (1988), that one or the other of the underlying principles of separation of the sexes or the normativity of the male be broken. What the reformers could see as their task, insofar as it considered gender, was to change the separation of the sexes in the overall gender contract in the area of technology by getting more women among the men into computer engineering education. This was to be done by breaking the normativity of the male in the institutional gender contracts, to create educational programmes where the male would not be the norm. However, the male patterns and traditions did not give way to radically new ones at either one of the institutions to any great extent. Rather, some changes which were assumed to answer to women's needs were accepted in addition to the old ones.

The starting point of the game can be described as there being a cultural overlay designating computer engineering as a male area. On the social integration level, in engineering education institutions the fact of there being women has been handled by designing a special gender contract, where women in computer engineering are designated as special. On the individual level many women have encountered token problematics, which they have learnt to handle, for example by not stressing their sex in social interactions, or not taking too much space. Both the separation of sexes (with some women making exceptions) and the normativity of the male are apparent.

The earlier efforts to change the gender contracts have had as their point of departure the definition of the women as the problem.

Women have been regarded as the abnormal, who have not understood their own best when not going into computer engineering in spite of all its rewards. The radical idea which started off the projects and has been spread somewhat since then was looking at engineering education as the problem. Even if the concept of gender contracts was not used, the idea was that there was something other than a false image of engineering that deterred women from computer engineering. In this case it was named teaching methods - but the shift in ideas may have opened a window for looking for other structural reasons in projects to come.

However, even if the liberal feminist ideology, where the individual's informed choice was focused, was abandoned in the rhetoric, it still marked the reform work. The idea of women and men as parties in a conflict about the definition and governance of computer engineering did not gain any foothold in either reform group, but the question was still handled as making concessions for a group that was needed in computer engineering. It was still seen as a question of putting an end to discrimination, even if it was hidden discrimination. It also seems that the main idea (in the practical planning work, regardless of what was expressed in the rhetoric) was not to recruit women who were very different from those in the system now, but rather to smooth the path of a greater number of students of the same "engineering" kind. The women who would come were expected to compete on the same conditions as other students on the programme – no special remodelling of the programme for their sake, in addition to what were to be improvements for the men, too, would be made. The basic structures would still be the same, and the same for both male and female students.

To reach the ultimate aim of the projects, making computer engineering a female as well as a male activity, it is necessary, not only stop discrimination, but to break the gender contracts. How should the results be interpreted in this perspective? How about the separation of the sexes?

LiTH makes an interesting case, in creating a whole new programme. In spite of the efforts to give it the same content as ordinary computer engineering, it was regarded as special, and definitely not as something that could replace the ordinary programme. The risk, envisioned by the reform group, of it becoming a female programme, not of the same status as ordinary computer engineering, was evident. At the time of my last visit to the programme it still seemed to be in the process of gender-coding, so the results are uncertain.

The "risk" of the LiTH programme becoming regarded as a female programme may sound strange, considering the fact that half of the students were men. But here the special gender contract of engineering education plays a part: it is possible that, just as some women can be regarded as having a somewhat masculine gender, some men can be regarded as having a somewhat feminine gender. If the programme is gender-coded as female, this coding is probably even attached to the men on the programme. The way the students on the programme were viewed at the end of the first year makes this not unlikely. The LiTH programme seemed to attract students, both male and female, with other characteristics, more like those generally associated with feminine gender, than computer engineering in general.

At Chalmers the problem of gender-coding did not exist. The Chalmers programme seemed mainly to attract the same kind of students that it had attracted during the years before. Seventeen women, instead of the previous year's seven, enrolled in ordinary computer engineering, which means ten more women who are not separated from the male domain of computer technology. But it can be stated that the programme at Chalmers did not make a big difference in the overall separation of sexes in computer engineering, because the increased recruitment of women was moderate.

As to the normativity of the male, the integration of the sexes, to the extent that it happens, still seems to require that women are integrated in the masculine education, rather than transforming it. Neither of the programmes made really radical changes in the subject matter, so assuming that the current content, planned by men in male institutions, reflects male interests, the normativity of the male has changed only marginally. Even when thinking about the working methods there is a risk that the increased amount of group work, without the corresponding training for the supervisors to see to gender differences, gives the male students a chance to see to their interests and neglect the interests of women (Salminen-Karlsson, 1998).

To conclude: the projects have managed to diminish the separation of the sexes in the area of computer engineering to some extent, by recruiting some more women, but at the same time there is a certain risk, especially with the LiTH programme, that the separation of the sexes moves inside the frames of the educational institution. The normativity of the male has, at most, been disturbed a little.

The normativity of the male, one of Hirdman's two prerequisites for the prevailing gender contracts, is part of the habitus, which it is the task of even the new programmes to inculcate if they are to reproduce new members who are suited for aspiring to positions in the engineering corps. It remains unquestioned in the context - it is part of the doxa in the world of the reformers. According to the Bourdieuan theory it is easy to see why the masculinity of the educational environment and the new programmes was never brought to the surface. The normativity of the male is an important part of the cultural arbitrary of the dominant group, which has to be both concealed and inculcated by the educational agent, to benefit those who confirm to the norm, and thus enable them to stay in the dominant position.

Possibilities for change

As we have seen, there is quite a lot of unquestioned doxa in the context of engineering education, and the habitus of engineering faculty often makes it difficult for them to see the restrictions which lie implicit in the concepts of an engineer and an engineering programme. On the other hand, as Becher & Kogan (1992) state, only engineering faculty on the basic unit level can reform the curriculum which they will then follow in their work with the students. Thus, while engineering faculty seem to be the only agents who really can enforce even such reforms that can break gender contracts in the education, at the same time they seem to be limited in their views of what is possible and thus are unable to make such radical reforms as would be needed to change the contracts.

What seems to be lacking here is the possibility to shake the habitus of the reformers and the institutional gender contracts, especially on the symbolic level (the image of women as a feature, the image of a gender-inclusive education as necessarily being less technical), from the inside. If the work has to be done by individuals in the basic units of engineering education, what can be done for it to succeed better?

There is an apparent need of knowledge, for example about gender and technology, about genderized - and other - interaction patterns. But that is only a very basic prerequisite. Habitus is not only knowledge, it is formed in action, in the interactions where an individual tries to struggle into an advantageous position in her context. Besides, habitus is durable and rather perpetuates the structures it is formed by than tries to upset them. Even if the reformers themselves were knowledgeable, in the context there are the whole weight of the traditions, the unquestioned doxa, the importance of status in relation to femininity, the opponents and those who are indifferent but potential opponents - all of them restricting the liberty of action of those who try to reform.

Engineering education institutions are quite autonomous. Getting through the mission, not only on the basic unit level, but also on the institutional level is important, as can be seen in the difference between Chalmers and LiTH. The mission of recruiting more women to get better students is easier to implant than the mission of designing an education that does not only answer the needs of men, but even of women, so the argument of recruitment, even if in itself disputable, may have to substitute for the equality argument to get anything started.

The autonomy of the education is, according to Bourdieu & Passeron (1977), a major contributor to its capability of inculcating a special habitus and so perpetuating the prevailing power relations. In this light, an opening up of the education is a prerequisite for starting to question the unquestionable and breaking the weight of traditions. Even if the reform work must be done by people in the basic units, they can be supplemented by people from other disciplines, or people outside the university, in addition to people who know about gender. It should, in fact, be natural, as part of the reform would probably be opening up computer engineering itself, and permeate it with knowledge from other disciplines. The problem is that of status. In the LiTH reform group there was one social sciences representative, who came to represent everything that was outside technology, science and mathematics. She never had much say in the process. It is difficult to do that, as the prevalent impression both at universities of technology and even on the levels above is that it is only engineers and engineering educators who understand what engineering education should be about.

My study is a contribution to questioning this assumption. It is probably true about several educational programmes that they would benefit from being scrutinised by somebody from the outside, and I suggest that this is especially true about programmes which have a strong effect of habitus formation. An important issue about computer engineering education is its male domination, and to come to terms with it, it is not enough just to get more knowledge of the phenomenon. This knowledge and its implications also have to be inculcated, so that they become part of the habitus of a sufficient amount of engineering education reformers. As habitus is formed in social interaction, this inculcation has to happen in the daily life of an institution and be perceived as not coming from the outside but being an integral part of the daily functioning (for example reform work) of a basic unit.

I have no suggestions about how this could be done. But I do believe that both general societal assumptions about computer engineering being a concern almost exclusively of computer engineers, and institutional closure, regarding the scholarship and the experiences made outside engineering as being of limited value, need to be loosened up, so that women and men from other, particularly from female-dominated areas, can give their views and be listened to when reflecting on what the matter is with computer engineering education, and how it should be improved to make it hospitable for both women and men.

Of course, this means breaking societal gender contracts, where computer engineering both culturally and institutionally is governed by the male corps of computer engineers. Seeing the problems already on the state authorities level with finding a common agenda for disturbing the contracts in the area of engineering education, and then thinking of the strength and multiple forms of these contracts on the institutional and individual levels, does not give much hope for any revolutionary changes. But, as Johansson (1997) states, perhaps reforming these two programmes is a first step in the process which will take generations.

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248

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Appendix 1

Persons interviewed and the year of the interview at LiTH and Chalmers, respectively.

LiTH	**1994**	**1995**	**1996**
0001	x	x	
0017	x	x	
0101			x
0209	x	x	x
0320	x	x	
0601	x	x	x
0709			x
0720	x	x	x
0910			x
1017	x	x	x
1109	x		
1207	x	x	
1209		x	x
1311	x	x	x
1324	x	x	
1611	x	x	
1621	x	x	
1911			x
1917	x	x	

Chalmers	**1995**	**1996**
0019		x
0201	x	
0211	x	
0500		x
0504	x	x
0505	x	
0514	x	
1107	x	x
1112	x	x
1201	x	x
1401	x	
1416	x	x
1501	x	
1616		x
1617	x	
1712	x	

Appendix 2

Interview questions

Interview questions at LiTH, 1994

Why did you get involved in the work with the program?

What do you think about the idea in itself, of taking special measures to recruit women into master of engineering programs?

In the group there seems to be a very basic unanswered question intriguing you all: Why are girls not interested in technology? What is your answer to that question?

Are you acquainted, outside the university, with girls or women who have an interest in technology?

Women hardly ever become hackers, not even those enrolled in computer engineering. What do you think is the reason?

Those women who are on the ordinary computer engineering program, how do they like their education?

How would you describe their social situation?

It is often said that women have poorer self-confidence than men. Do you think that it is so - even outside technical areas?

Do women and men learn differently?

In the meetings you have talked about educating creative engineers. Do you think women and men generally show the same kind of creativity?

This program has two basic principles - recruiting women and problem-based learning. I know that different team members emphasize these principles differently. Which one is more important for you?

Why is problem-based learning good for women?

How should this programme be marketed to those you hope will apply? Should you have the same marketing for boys and girls?

When the students graduate from this programme, after five years - what do you think about their prospects on the labour market, men's and women's, respectively?

Where do you think you would find them later in their life? Would men and women get into the same areas?

What do you think about gender equality in society in general?

What do you think about gender equality in the future, in society in general, say, thirty years from now? What changes have there been, if any?

Let's say that the recruitment of women into engineering becomes successful, and you get some forty percent of women at the university. How would it change the university and the education - or would it?

What do you personally believe about the possibilities of the new programme to recruit women? How many women will you get?

Interview questions in 1995, LiTH and Chalmers

Could you start by telling me the history of the programme this far? (It started with...)

How about the female-friendliness? Has that aspect been catered for in the planning work?

What has your role been? What have you contributed with?

How would you evaluate the planning work in itself, how has it functioned?

What do you think about the programme in itself, as far as you can see now? How do you like it?

What is good for women in the programme?

If you were to go out and "sell" the programme to secondary school students, what kind of image would you try to give? What would you say?

Is the programme talked about at your department? What kind of comments are there?

Do you know anything about the rest of the university? What do they know about the programme? What are the attitudes towards it?

How is the programme viewed higher up in the institutional hierarchy?

In general, what is the attitude at your institution towards recruiting women?

If you think in a longer perspective, what could be the impact of the programme on the university or on engineering education in general?

Would something have happened without the money?

How many women would you guess you will recruit when the programme starts?

Questions at LiTH:

What should I call the programme when I'm interviewing you - Q or IT? Why do you prefer that abbreviation? (Opening question)

How about my tape-recording in the meetings, do you think it has an effect on what is said? (Closing question)

Noah's principle, having an equal distribution of men and women in the team, does it make a difference?

Questions at Chalmers:

Why did you get involved in the reform?
Why should there be more women in computer engineering?

Interview questions in 1996, both LiTH and Chalmers

What has been the most striking feature about the first year of the programme? If somebody comes after ten years and says: "Oh, you were there when the programme was created/reformed, tell me about it" - what would be the first thing that came to your mind?
What is good for women about the programme?
There was some talk about recruiting another kind of women during the planning phase/in my last round of interviews. How is it - the women you have recruited this year, are they different from the women in ordinary computer engineering?
Do you think about the female students when you teach?
How is the academic performance of the female students, compared with the men?
How do you think the female students like the programme?
How have the female students managed in their groups?
What kind of preparation did the teachers on the programme get for their task?
Were gender aspects taken up there?
Has working on this programme given you something extra?
Do you know how the programme is commented on at the rest of the university, now that it is working?
What do you think about the recruitment of female students to the programme next year? In the long run?
The recruitment of women into computer engineering has been a problem at all technical universities. You have succeeded in recruiting many women. Do you think you have found the solution to the problem?

Question at LiTH:

What is your explanation for the fact that you managed to recruit almost fifty percent women?

Question at Chalmers:

The year before you had seven female students in computer engineering and now you have more than doubled to seventeen. Does it make a difference, having seventeen female students instead of seven, out of a hundred?

Appendix 3

An example of an interview analysis

In this example analysis is made to look mechanical, like a number of steps leading in succession from the interview to a thesis. Naturally the process was not linear. The process described here served as a device for me to become acquainted with the data, to make my brain concerned with it, to form a foundation for a creative process and as something to go back to after the insights generated by the creative process, to verify the results of this process.

1. Coding an interview into statements

The following is an excerpt from an interview with one of the Linköping teachers in 1996. The words of the interviewer are written in bold.

In the coding phase this excerpt was divided into sections of a few lines and these sections were coded twice, with a time lag between: 1) In every section what I regarded as the most central message was underlined. 2) For every section an interpretation of the content was summarized in a few words and written in the margin. (In the excerpt below it is written instead in italics after the section.)

What is good for women about the programme?
It's that forty percent of the students are women. I believe that's the only thing. **PBL is not good for women?** I don't believe so. **After one year's experience of this kind of teaching?** No, I don't see that it would actually be, in itself. But I mean it can be, if the women take, take the command and direct the discussions and the content. But I don't believe automatically that... I mean, if there is a male-dominated group and there is only one woman there, I don't believe she benefits in some way if you have PBL in the group, rather the other way round.
Many women - women-friendly

But the groups you have had, you have had two or three women, like ... almost half a group?
Yes, but I don't believe... No, I don't really think that they have benefited from the method, either. Because... it can be that the examination has been very conventional, very traditional. And that's also something that hits the social science group that the possible advantages they have, those have not been done justice to, because we have examined according to the old model.

Examination unfair towards other perspectives.

Oh yes. Because there was this idea that the women and the social science students should come in partly because... because then you get a wider perspective in discussions, you get another way of approaching the problems and so.
It can have been so. But the examination has not been adapted to it at all.

OK. You tutored one group, didn't you? Yes. How was it in your group?
There were three women in that group... and those three, they have had problems with their exams. Like... two of the guys have done well and the rest, five of them, have had quite big problems. And those two who did well, they both have studied at university before, one of them has had, I think it was, I don't know how many credits in mathematics, it was quite a lot.
Most students in the group had problems with exams

Yes. I saw in the group...the first time we met, it was one of the younger guys who dominated the group. I think we all thought that he knew a lot. But after a couple of things, when it became clear that he did not actually know everything that he and the others thought he could, he kept a very low profile and was very quiet in the group and some others took over instead.
One of the guys bluffed to start with.

Here the social sciences students fall out from the next step. When it becomes clear that they are an issue (after coding all the interviews) a return to the interview can be used to support statements about them.

2. From statements to thematic groups

Here I only go further from the italicized statements. A similar process was done with the underlined utterances. In both cases, during the categorization, repeated returns to the interview were necessary to find out what the short coded statements actually meant. In this interview the discussion about what was good for women about the programme produced four statements:

Many women – women-friendly
Examination unfair towards other perspectives.
Most students in the group had problems with exams.
One of the guys bluffed to start with

After coding all answers to this question in the Linköping interviews there were 36 statements like this to try to puzzle together. Three of the statements from the interview above came to belong to three different groups. No group could be created where the fourth one could belong. Below I show statements which resulted from answers to the question about female-friendliness in several interviews, and form basis for thematic groups.

Many women – women-friendly
You count on women because they are there
A consciousness that women need space – few women on computer engineering – women on computer engineering disappear because they are few.
This group was called: **The number of women makes them visible**

Examination unfair towards other perspectives
Not many female perspectives in the beginning
Women did not take up female perspectives
This group was called: **Women did not take up other perspectives**

One of the guys bluffed to start with.
Small groups: individual roles more important than gender.
Three very different women in the group.
This group was called: **Individuals become visible in small groups**

The problems with the exams was not pursued further in this context, as it in connection to this question was only this one statement which touched upon the issue. However, it could be used to support the idea of examinations being a problem, once this idea had emerged in the context of another interview question.

One other group which emerged from the answers to this question was: **Group-work is woman-friendly.**

When groups which had emerged from categorizing the underfinined parts were compared with these, some differences emerged. "Individuals become visible in small groups" or "Groupwork is woman-friendly" did not emerge as categories of their own. Instead there were groups called: **Some women are very ambitious, others are not** and **Content is not women-friendly, rather the opposite.**

The differences between these two categorizations can be explained partly by the fact that during two different readings two different meanings emerged as important in the text. It may not have been totally different factual content, but rather a difference in emphasis, which directed the statements into different categories. Another factor is probably that categorization always starts with some statements and is filled with the others, and the way the first categories are created tends to influence the categorization of the later statements. As can be seen, here the thematic groups are quite alike. The differences do not conflict, but rather illuminate the issues.

3. From thematic groups to working paper

The thematic groups of statements which emerged could be regarded as teasers – here was something to think about and look closer into. All thematic groups (from the 10 interviews Linköping in 1996 38 of them emerged) were compared with each other to see whether similar issues were taken up in other questions in the interviews and whether there were larger themes which these thematic groups were an indicator of. This phase involved a lot of writing – of jotting down assumed connections between thematic groups, of posing questions about others. For example, the statements that women had not taken up different perspectives could be combined with a thematic group of statements from a question about the role of the teacher **(Not paid attention to gender in teaching)**, and a group of statements from a question about teacher training **(No gender, PBL difficult enough)** to a chain of thought about the difficulties of the female students in influencing the content of their studies. This chain of thought, first jotted down quite rudimently, was kept in mind during the subsequent checks and readings of the interviews to see whether it was compatible with the overall meanings.

This concluding phase is the most difficult to describe, as it was the most creative. By this time the work with the data had given me quite a good idea of what was in there, and I had a certain picture of which themes had been taken up often or explicated in detail and in which contexts. One of the functions of coding and thematizing my data the way I did was to arrive at the thematic groups, to see which issues could be found in the data, but another was to give me a subtle intuition about the data, which would enable me to think about it creatively.

After the same procedures had been carried out even with the interview data from Chalmers, the thematic statement groups of both universities were compared for similarities and differences. This could both strengthen the importance of some issues as well as awaken my curiosity about the differences.

The thematic group of statements about women not having taken up other perspectives was transferred quite unaltered to the thesis (p. 157). But the group of statements which it comprised even formed part of the basis of analysing the general view of knowledge, or the idea of gender being interesting in social interaction but not in knowledge mediation. Those analyses were born somewhere in the to and from movement between the thematic statement groups and the interviews in themselves, but cannot be placed anywhere specific.

Appendix 4

Study plan får academic year 1995/96

Program for Information Technology, first year

1. To learn how to learn 6 credits
   Point of departure: Information retrieval

   Contents:
   Basics on computers and information retrieval
   Databases and frågespråk
   Discrete mathematics
   To communicate in writing

2. The Tools of the Engineer 9 credits
   Point of departure: Mechanical phenomena

   Computer science
   Mechanics
   Mathematics

3. The Engineer in the Society
   Point of departure:
   Situation in an industrial company 5 credits

   Communication in working life
   Design

4. Introductory mathematics 5 credits

   Basic mathematics
   Circuit theory
   History of science

5. Models in Physics 5 credits

   Continuing mathematics

6.Electromagnetism 5 credits

Continuing mathematics
Electromagnetism

7. Philosophy of Science 5 credits

Continuing mathematics
Modern physics
History of science

Appendix 5

Chalmers

Program for Computer Engineering, first year courses

Computer Science and Engineering in Context	4 credits
Fundamentals of Digital Systems and Computer Engineering	6 credits
Computer Programming	9 credits
Introductory Course in Mathematics	1 credit
Mathematics	13 credits
Engineering Mechanics	6 credits
Non-technical course	3-4 credits

Appendix 6

Some events on the projects at LiTH and Chalmers, as well as the research project.

	Common	**LiTH**	**Chalmers**	**Research project**
93 Sept	First applications			
93 Oct	Preliminary acceptance			
93 Nov	Refining applications			
93 Dec	Final acceptance			
94 Jan				
94 Feb		First official team meeting	Inspiration conference	First observations
94 Mar	National Council seminar			
94 April	Conference. Working groups			Interviews LiTH
94 May		Change name to IT		Interviews LiTH
94 June			Working groups report	
94 July				
94 Aug				
94 Sept		Governing board wants documents	New working groups	Interviews LiTH
94 Oct		Visits to schools		
94 Nov	National fair for secondary schools	Governing Board accepts program		
94 Dec	National Council seminar		New program secretary	
95 Jan				
95 Feb	National Council Seminar	Visits to schools	First outreach activities	
95 March	National Council seminar	Visit to Aalborg		Interviews both sites
95 April				
95 May		Locales arranged		
95 June	National Council seminar			
95 July				
95 Aug		First students come	First students come	
95 Sept			New building inaugurated	
95 Oct				
95 Nov				
95 Dec				
96 Jan				
96 Feb				
96 Mar		Students move to new building		
96 Apr				
96 May	National Council seminar			Interviews both sites

Appendix 7

Enrollment and attrition on the reformed programs. Status spring term 1999, the 8th term of the programs.

"Term 8 on the program" indicates students who have proceeded according to program plan. "On the program" indicates students who have taken leave one or more terms but returned. "Not on the program" indicates students not currently registered on the program. In this number are included both definitive dropouts and students on leave.

Percentages are of the total number of women and men, respectively, enrolled in 1995.

LiTH

	Enrolled in 1995	Term 8 on the program	On the program	Not on the program
Women	16	6 (37%)	5 (31%)	5 (31%)
Men	19	10 (53%)	2 (10%)	7 (37%)

Chalmers

	Enrolled in 1995	Term 8 on the program	On the program	Not on the program
Women	17	6 (35%)	5 (30%)	6 (35%)
Men	92	47 (51%)	26 (28%)	19 (20%)

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